9-1000-202-14/990

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT
AND GENERAL SUPPORT MAINTENANCE MANUAL

EVALUATION OF CANNON TUBES

This copy is a reprint which includes current pages from Changes 1 through 5

HEADQUARTERS, DEPARTMENT OF THE ARMY
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WARNING

Always make sure that the cannon and any attached spotting gun are not loaded.

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No. 5

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Washington, D.C., 11 July 1989

Operator's Organizational, Direct Support,
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EVALUATION OF CANNON TUBES

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None	3-126.1 through 3-126.11/(3-126.12 blank)
3-129 and 3-130	3-129 and 3-130
3-147 through 3-150	3-147 through 3-150
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Operator's, Organizational, Direct Support, and General Support Maintenance Manual

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1. Throughout this manual, change model designation M68 to M68/M68A1.

2. Page 3-27/(3-28 Blank), Figure 3-7, change illustration title to read: Progressive cracking after 12,000 rounds. View not clear enough. Use borescope mirror: ACCEPTABLE.

3. Page 3-29/(3-30 Blank), Figure 3-8, change illustration title to read: Progressive cracking after 15,000 rounds. Apparent cracks but use borescope mirror: CONDEMN (see figure 3-17).

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OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL FOR

EVALUATION OF CANNON TUBES

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For
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WASHINGTON, DC, 15 November 1976

Operator's, Organizational, Direct Support,

and General Support Maintenance Manual

for

EVALUATION OF CANNON TUBES

REPORTING OF ERRORS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Armament, Munitions and Chemical Command, ATTN: AMSMC-MAS, Rock Island, IL 61299-6000. A reply will be furnished to you.

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*This manual supersedes TM 9-1000-202-35, 25 November 1969, including all changes and TM 9-1000-202-10, 24 July 1970.

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CHAPTER 1

INTRODUCTION

1-1. Purpose and Scope

a. The purpose of this manual is to aid you in determining if a cannon tube can be used or condemned, in estimating the remaining life, and in determining how often a new tube can be installed into the breech ring or breech coupling. You will find information in this manual on tube life, wear, damage, and inspection procedures which will be helpful in making the right decision.

b. Parts attached to the tube are not considered here, except basecaps on mortars and vents on recoilless rifles. Whether mentioned here or not, all attached parts (which include such breech parts as ring, coupling, block, crank, obturator spindle, extractor, cams, springs, keys, operating handle, receiver, buffer, evacuator, muzzle brake, flash suppressor, vents, basecaps, plug brackets for a telescope or spotting rifle) should be inspected in accordance with operator's manual or direct support maintenance manual for the specific weapon.

1-2. Forms and Records

a. Authorized forms. Maintenance forms, records, and reports to be used by maintenance personnel at all maintenance levels are listed in and prescribed by DA PAM 738-750.

b. Field Reports of Accidents. The reports of injury to personnel or damage to materiel necessary to comply with the requirements of the Army safety program are prescribed in detail in AR 385-40.

CHAPTER 2

INSPECTION BY OPERATOR AND ORGANIZATIONAL PERSONNEL

Section I. GENERAL

2-1. Reason for Inspection

WARNING

Defective tubes may endanger the lives of using personnel by exploding or by inaccurate firing.

You should make an inspection of the tube to find any damage or erosion (wear). With information in this manual, you can decide if tube can be used or if direct support should be notified.

2-2. Types of Inspection

a. Records Inspection. Get the following information from equipment log book to help in figuring estimated remaining rounds:

(1) Number of rounds fired, and with what type projectiles or charges. If there is no complete record of number of rounds fired, notify direct support.

(2) Marking of breech when new tube is installed.

(3) Markings of vent number or adjustment on certain recoilless rifles. On 90-MM recoilless rifle, M67, serial numbers on tube and breechblock are the same, except that the latter may have a "-1" or a "-2" added to show it is a replacement.

CAUTION

Make sure equipment log book numbers correspond with those on weapon. See locations in figures 2-1 through 2-20. When making entries, do not confuse the numbers.

b. Visual Inspection. Examine weapon with naked eye. Use equipment in paragraph 2-4 when required.

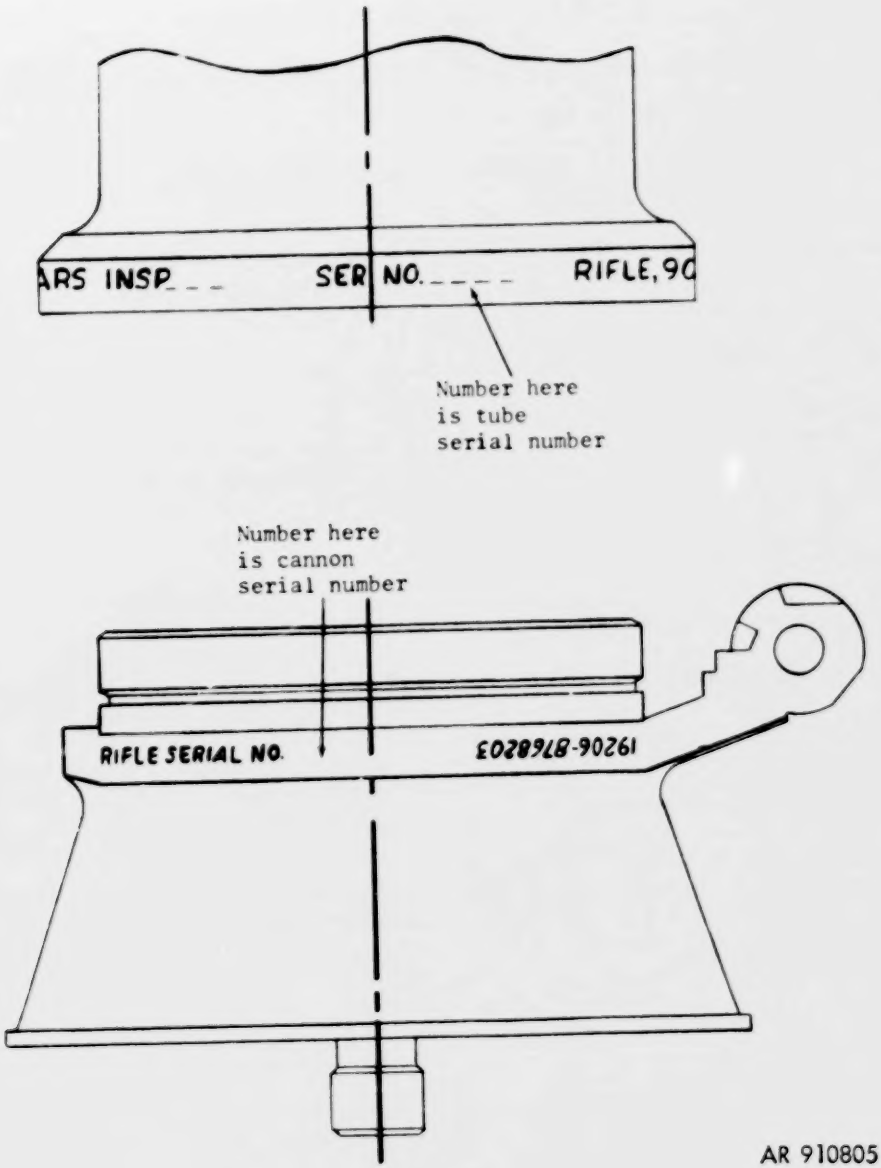

Figure 2-1. Location of tube and cannon serial number: 90-MM recoilless rifle, M67.

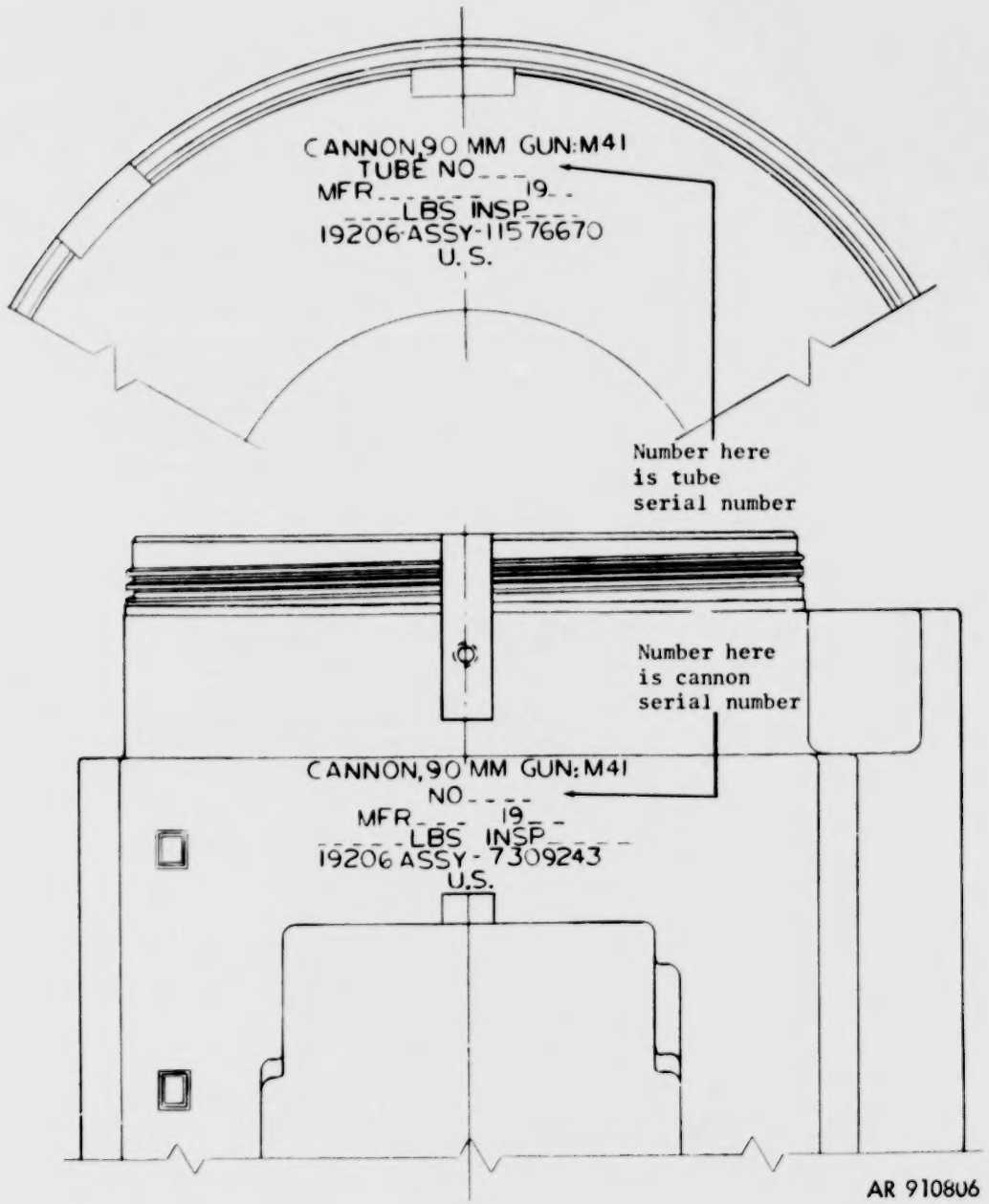

Figure 2-2. Location of tube and cannon serial number: 90-MM gun cannon, M41.

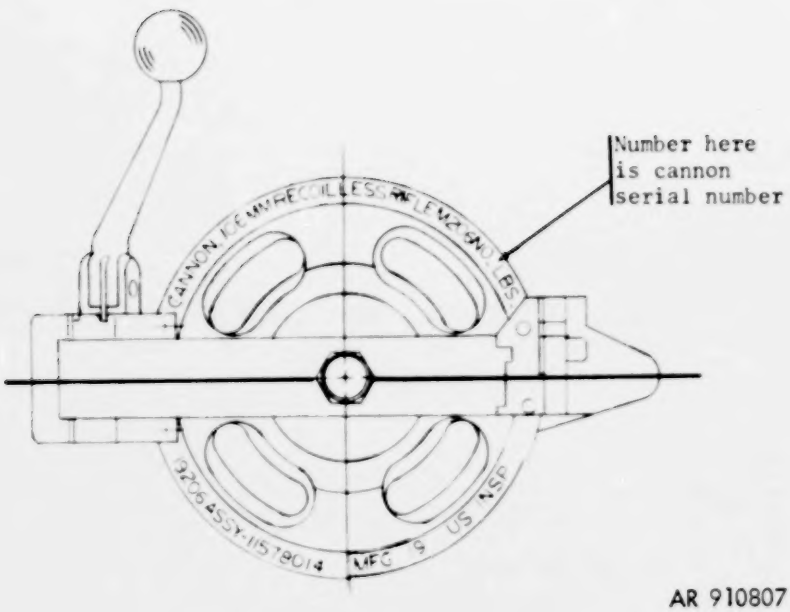

Figure 2-3. Location of tube and cannon serial number: 106-MM recoilless rifle, M40 series.

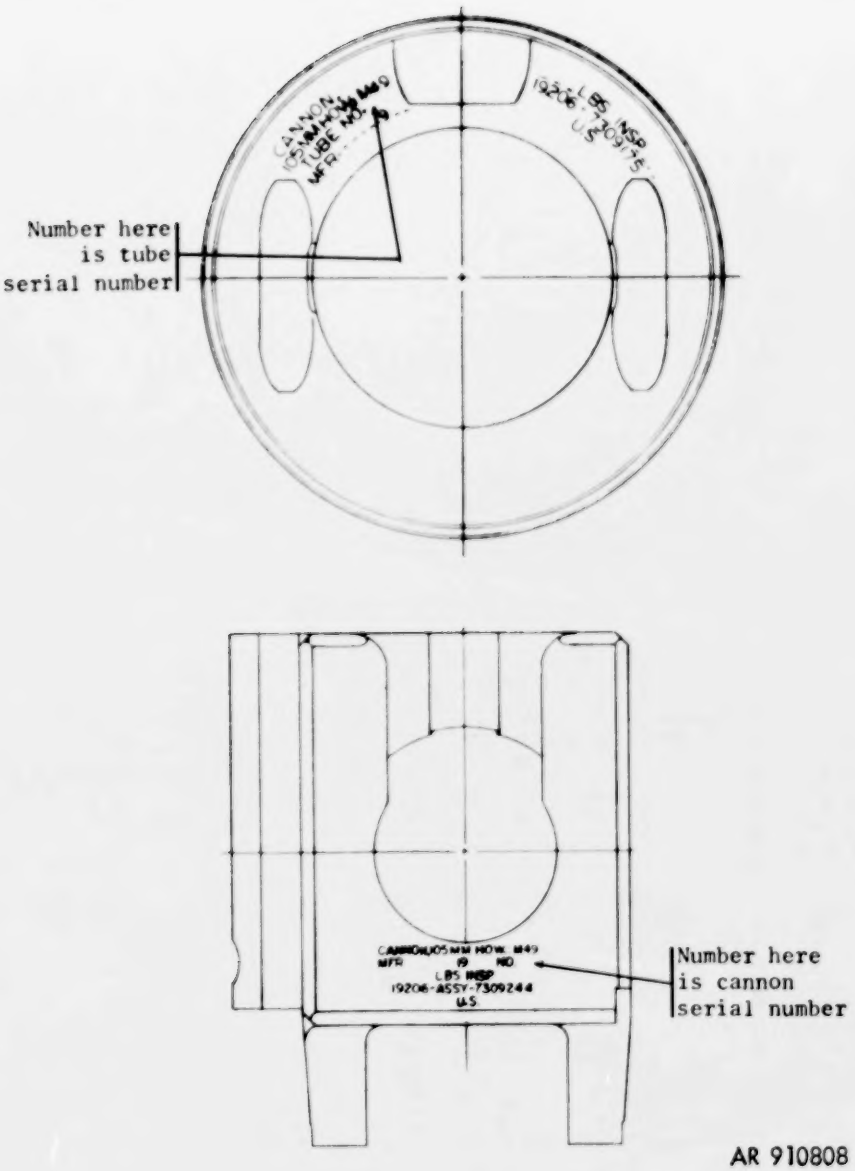

Figure 2-4. Location of tube and cannon serial number: 105-MM howitzer cannon, M49.

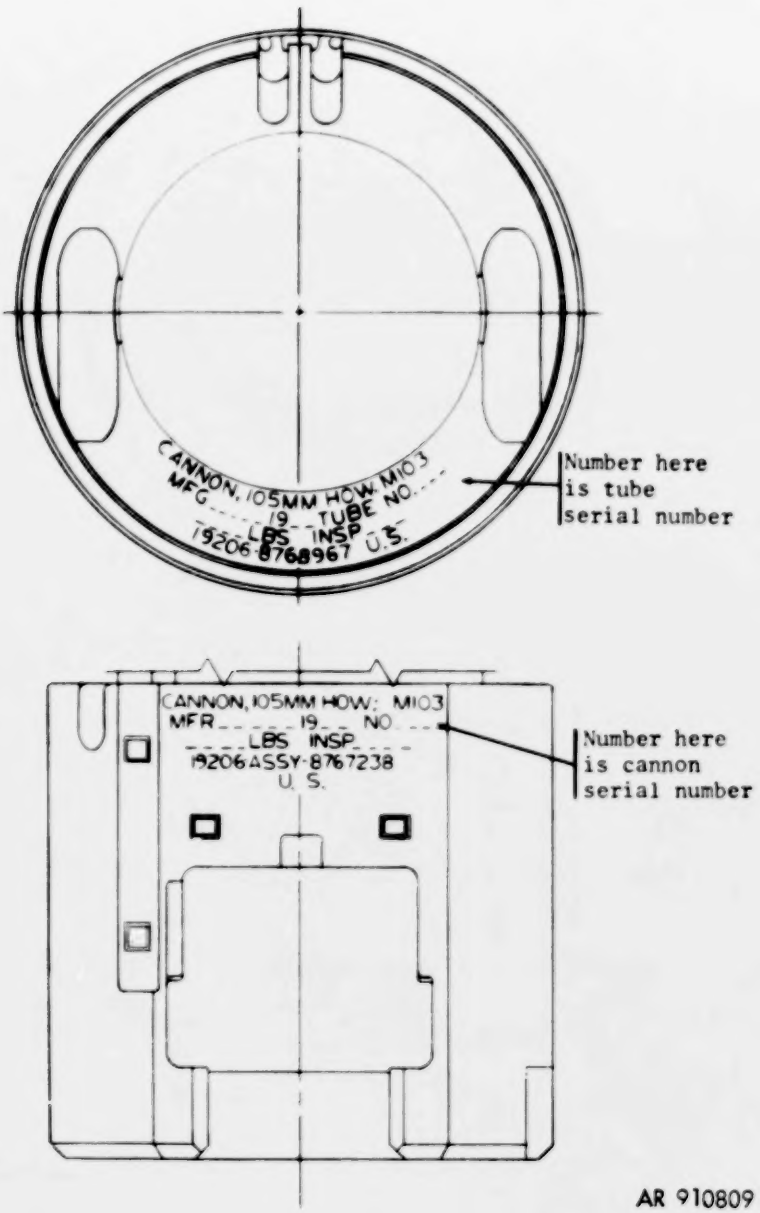

Figure 2-5. Location of tube and cannon serial number: 105-MM howitzer cannon, M103.

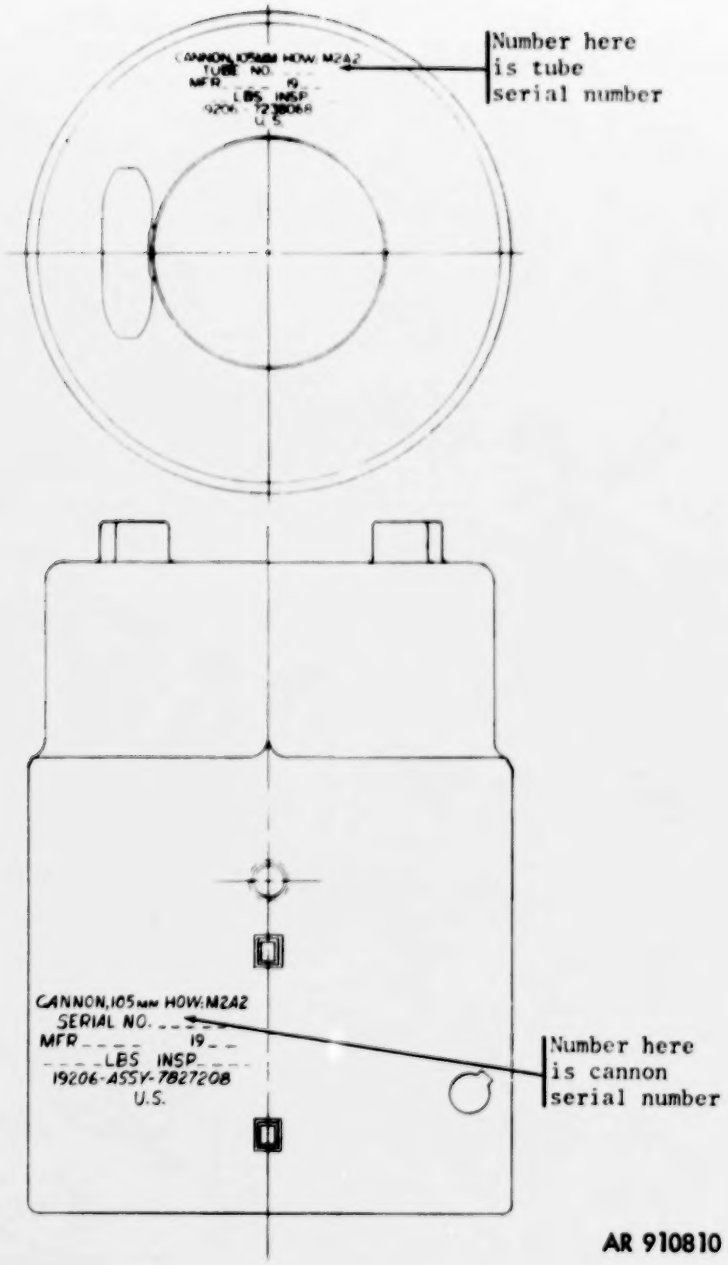

Figure 2-6. Location of tube and cannon serial number: 105-MM howitzer cannon, M2A2.

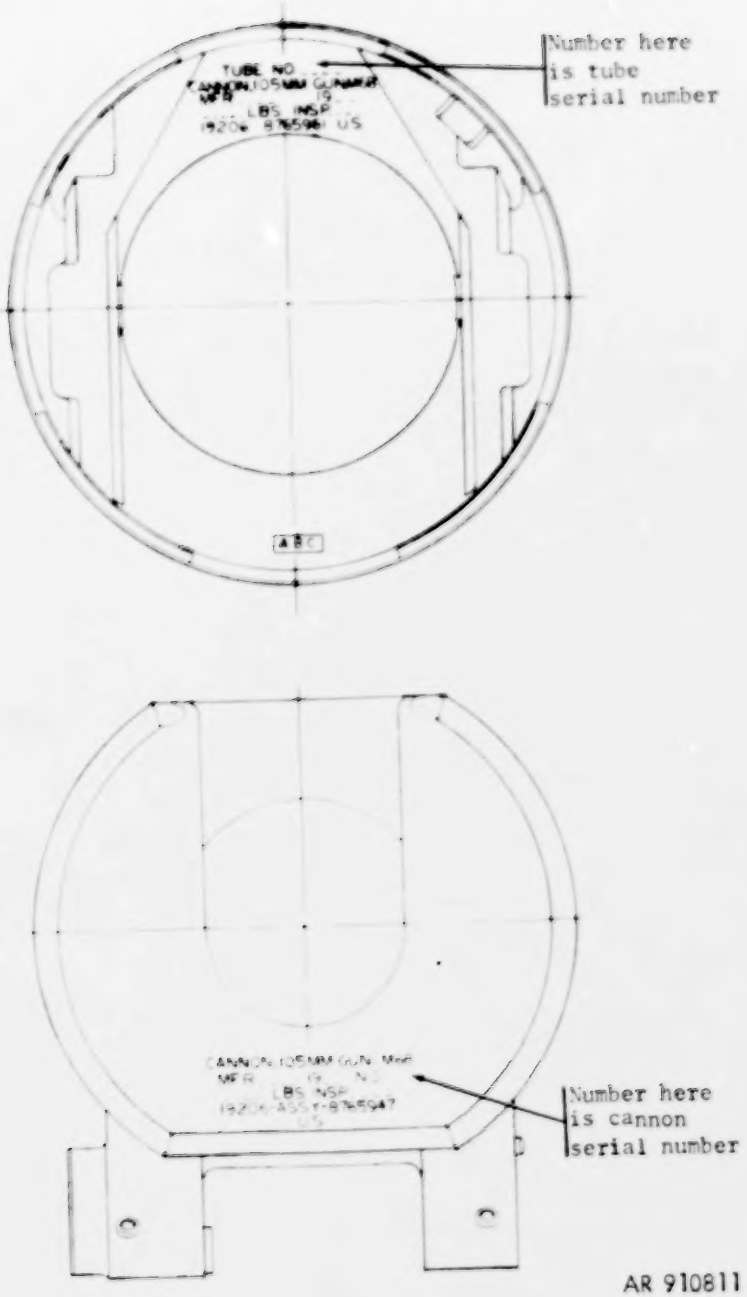

Figure 2-7. Location of tube and cannon serial number: 105-MM gun cannon, M68.

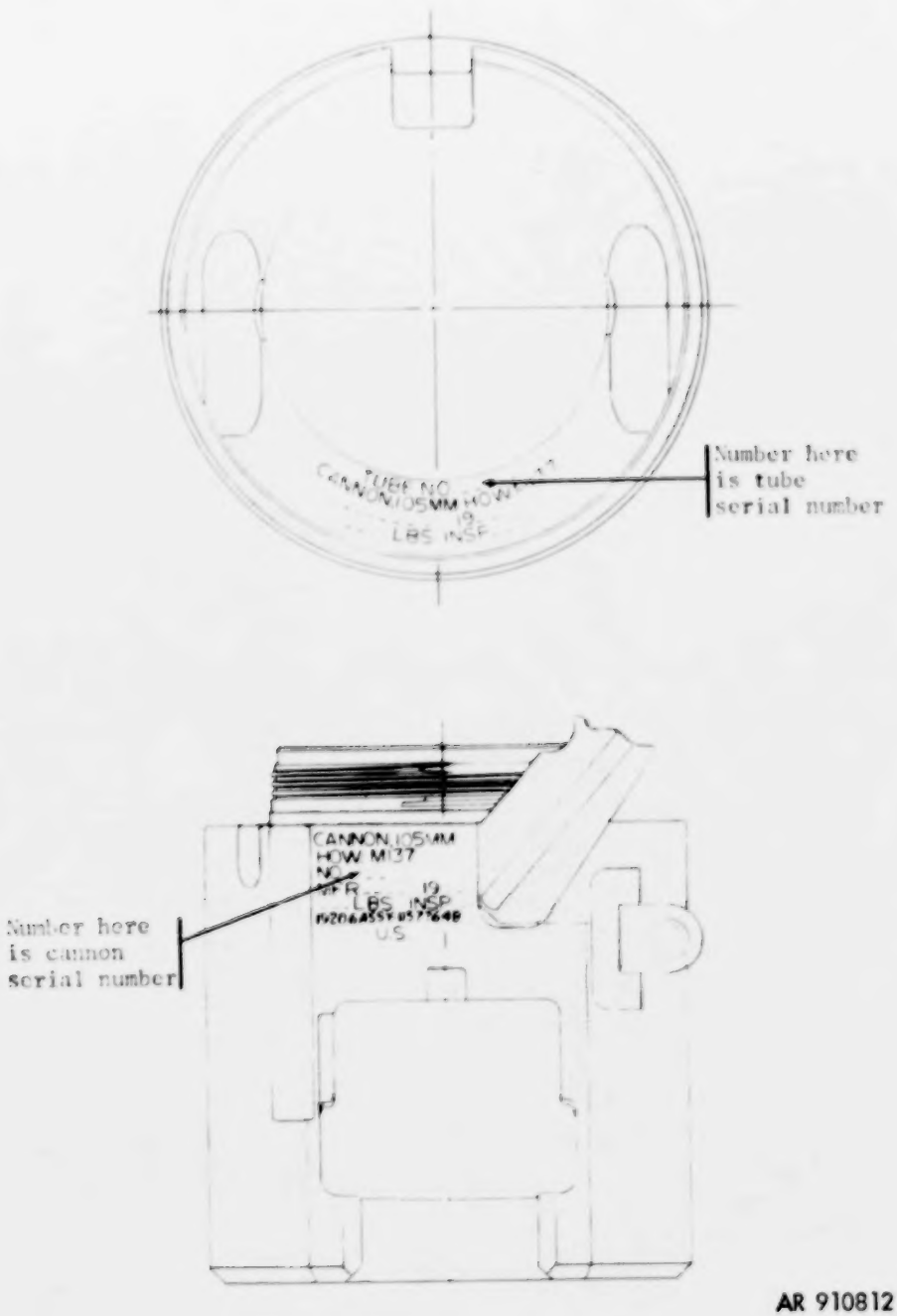

Figure 2-8. Location of tube and cannon serial number: 105-MM howitzer cannon, M137.

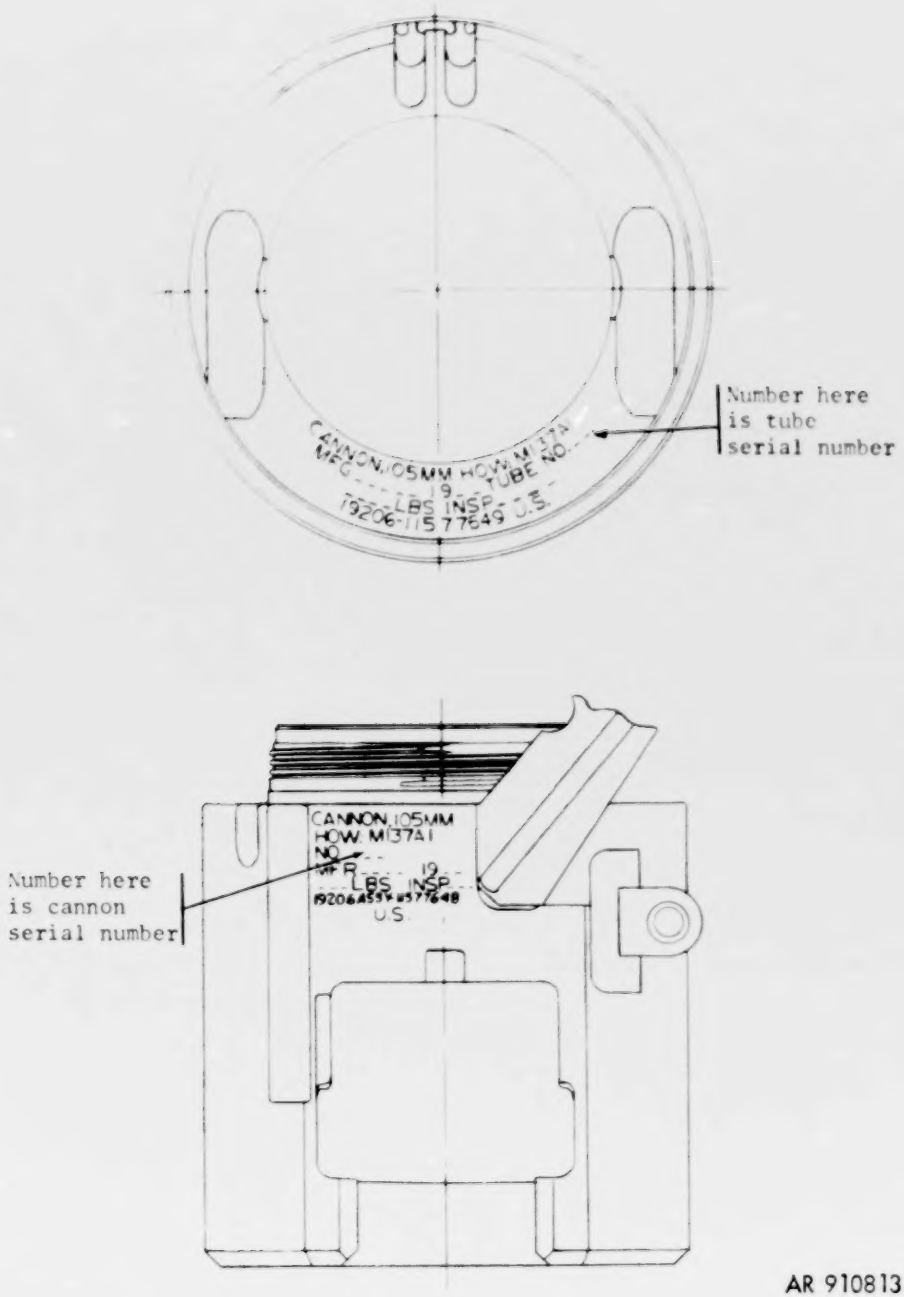

Figure 2-9. Location of tube and cannon serial number: 105-MM howitzer cannon, M137A1.

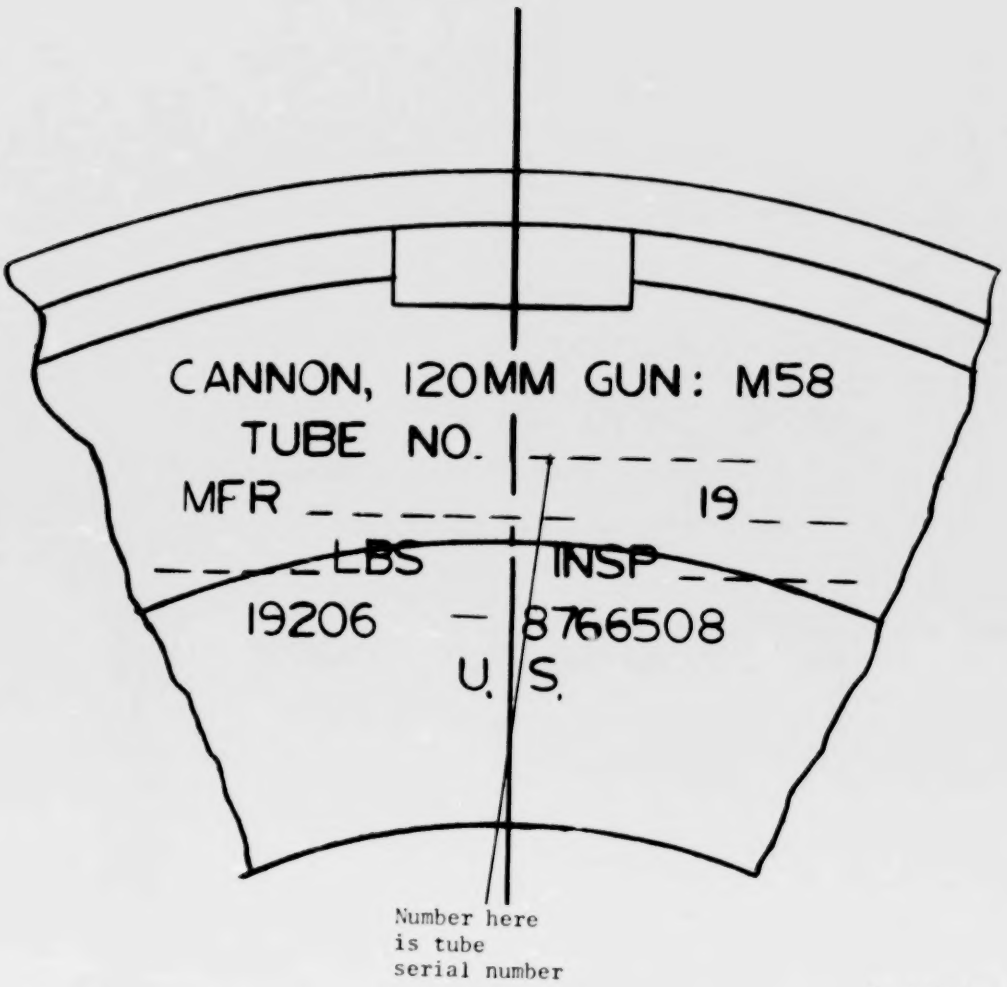

Figure 2-10. Location of tube and cannon serial number: 120-MM gun cannon, M58.

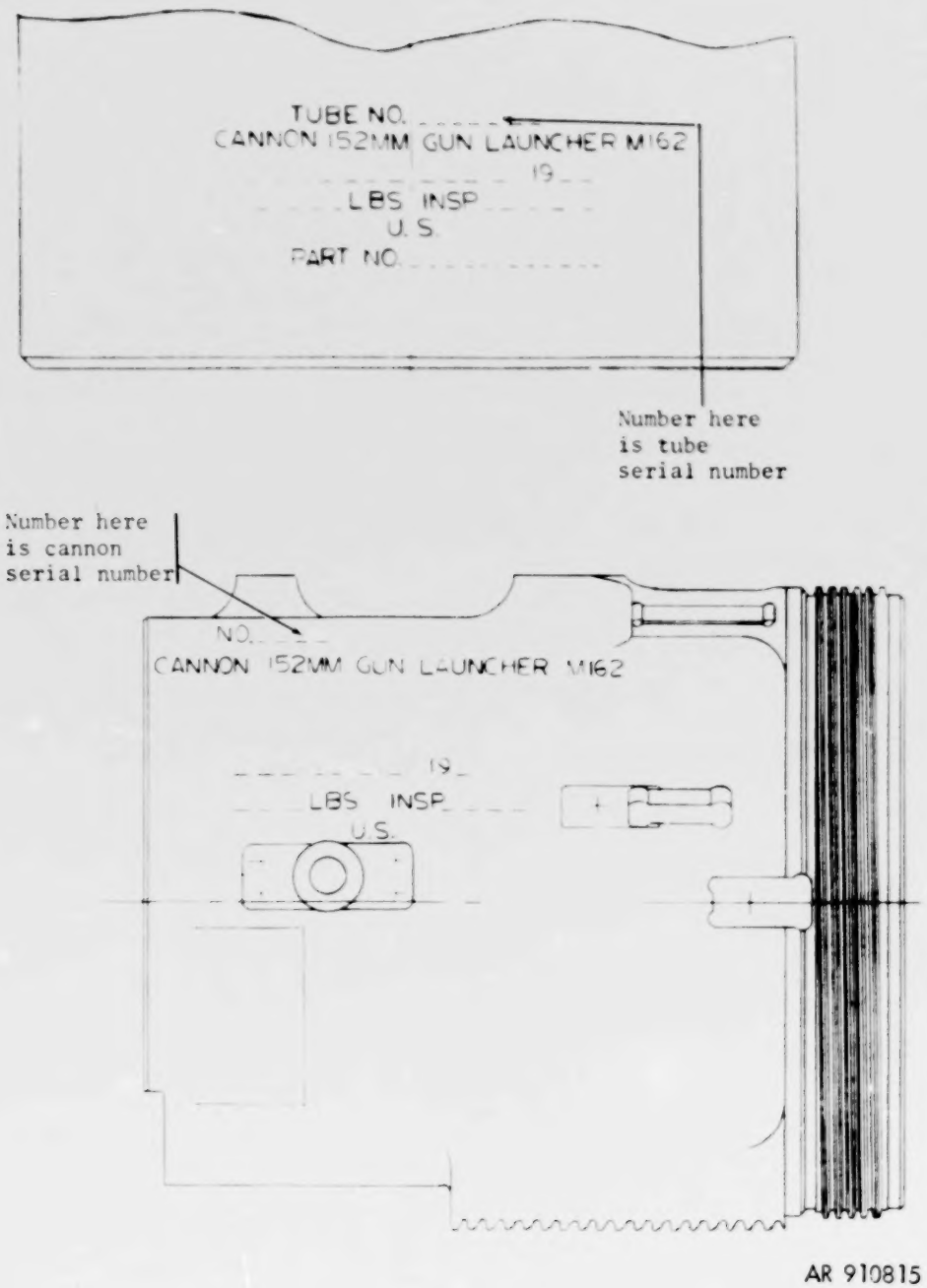

Figure 2-11. Location of tube and cannon serial number: 152-MM gun launcher, M162.

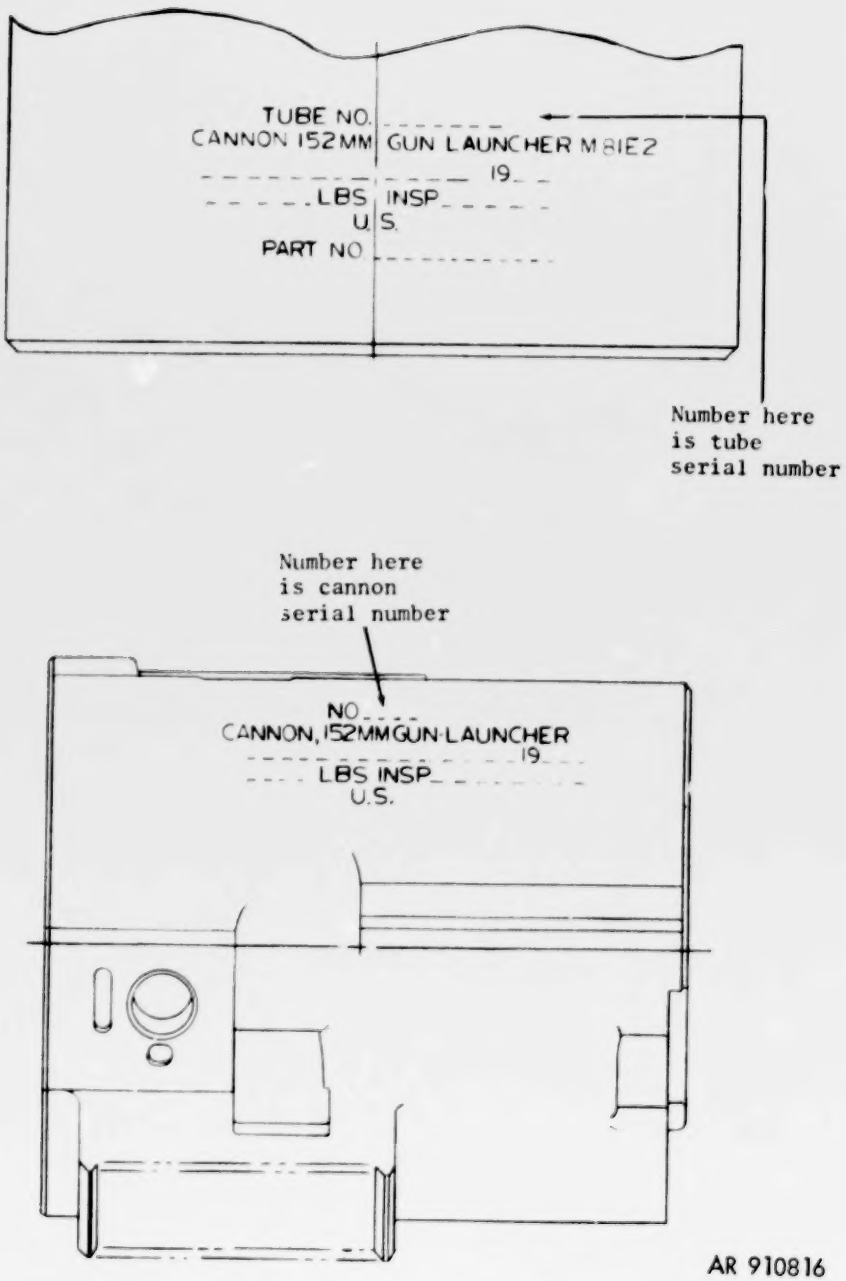

Figure 2-12. Location of tube and cannon serial number: 152-MM gun launcher, M81E2.

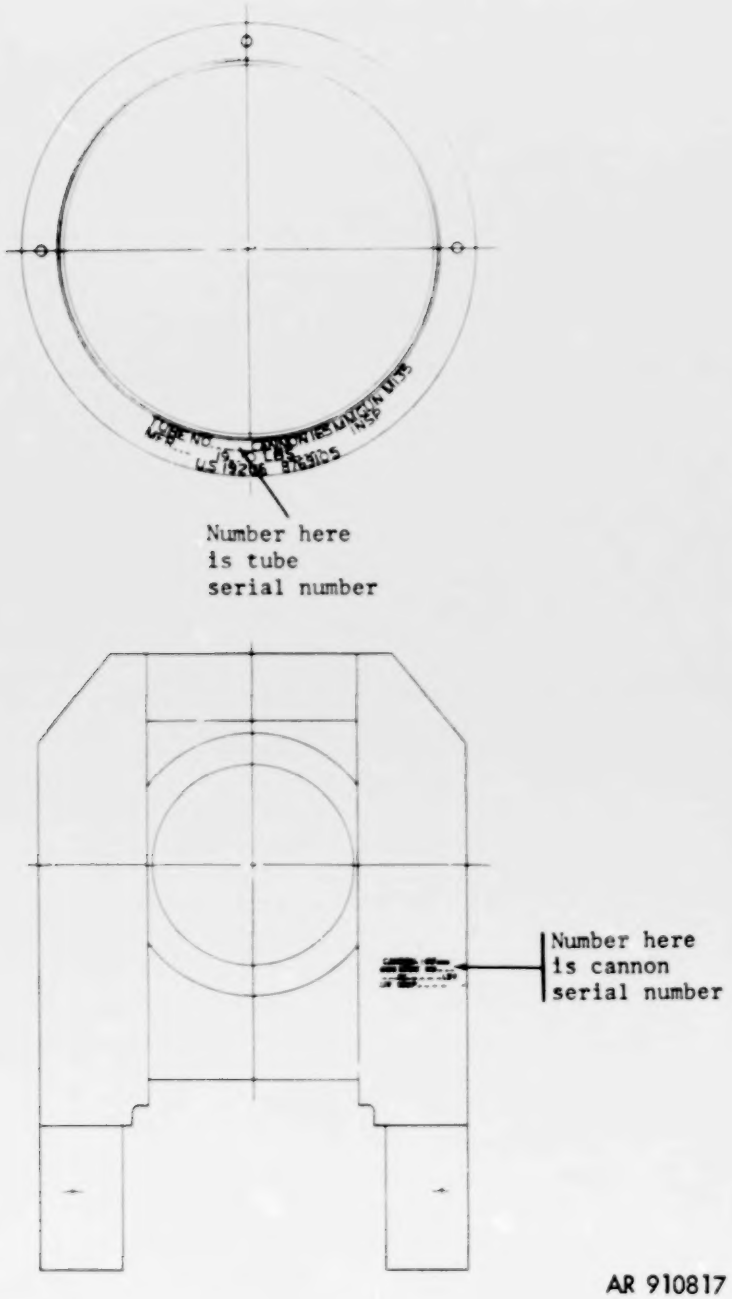

Figure 2-13. Location of tube and cannon serial number: 165-MM gun cannon, M135.

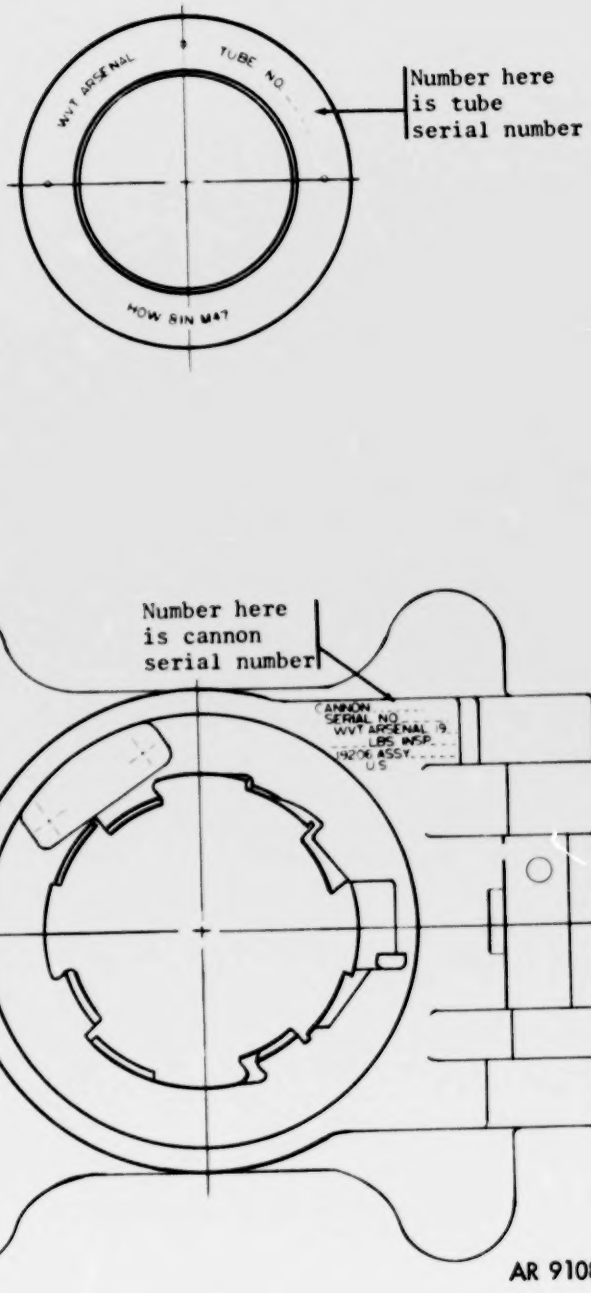

Figure 2-14. Location of tube and cannon serial number: 8-inch howitzer cannon, M47.

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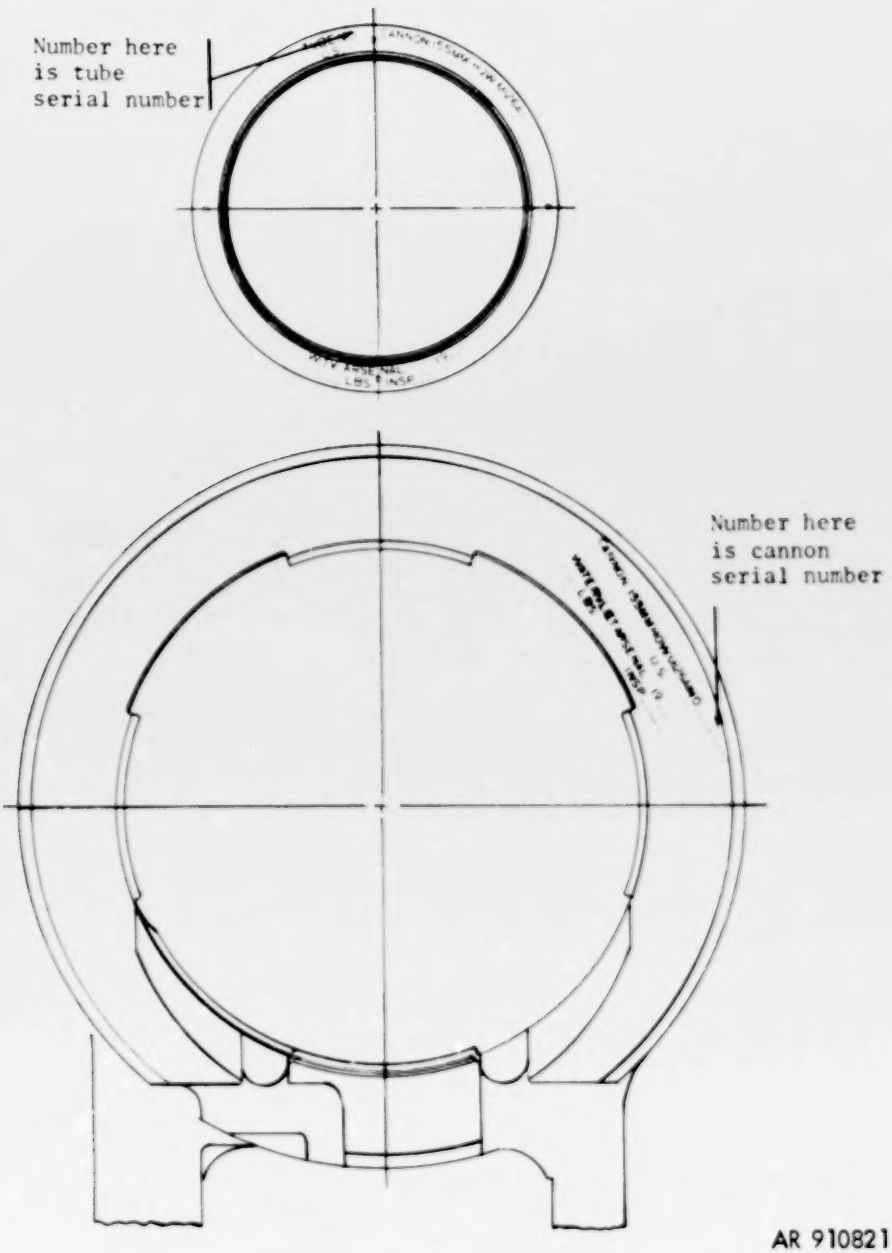


Figure 2-17. Location of tube and cannon serial number: 155-MM howitzer cannon, M126A1.

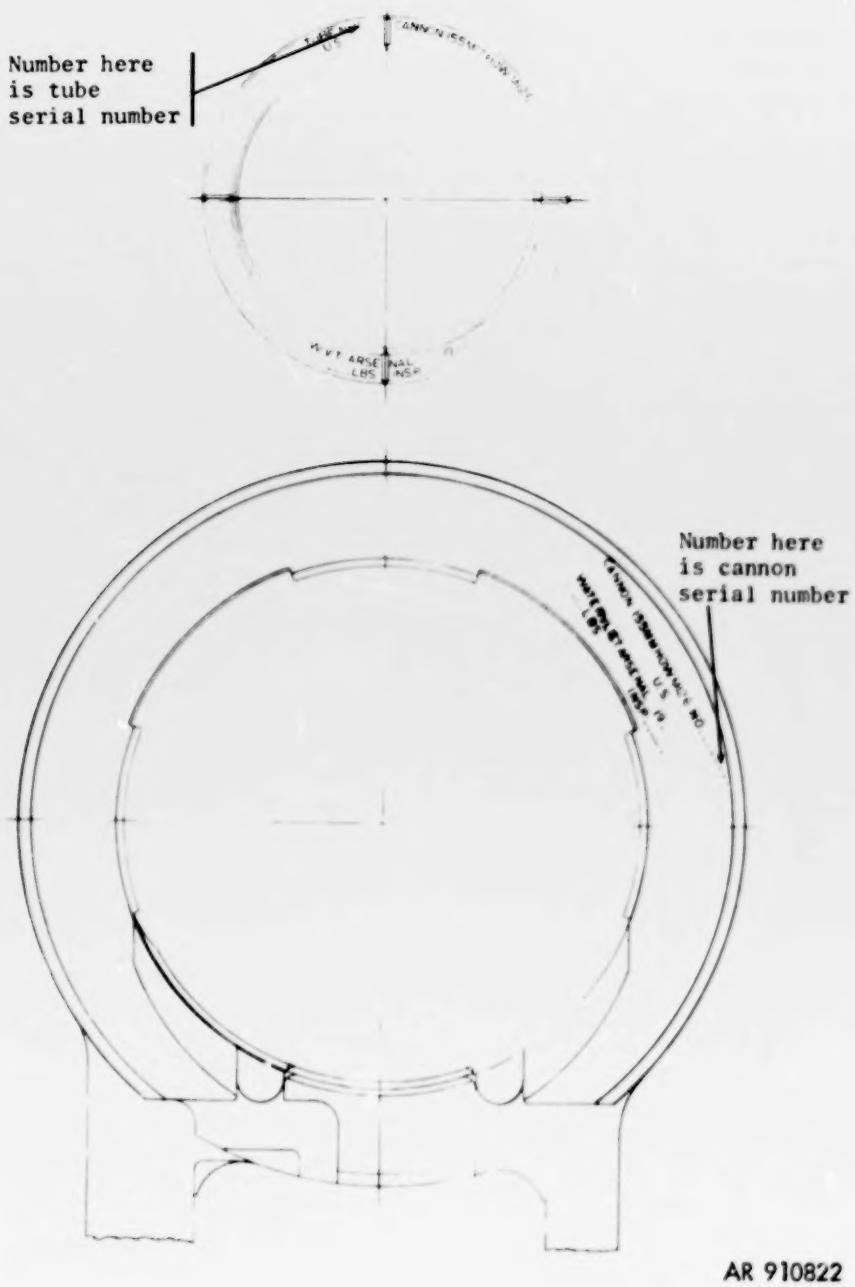


Figure 2-18. Location of tube and cannon serial number: 155-MM howitzer cannon, M126.

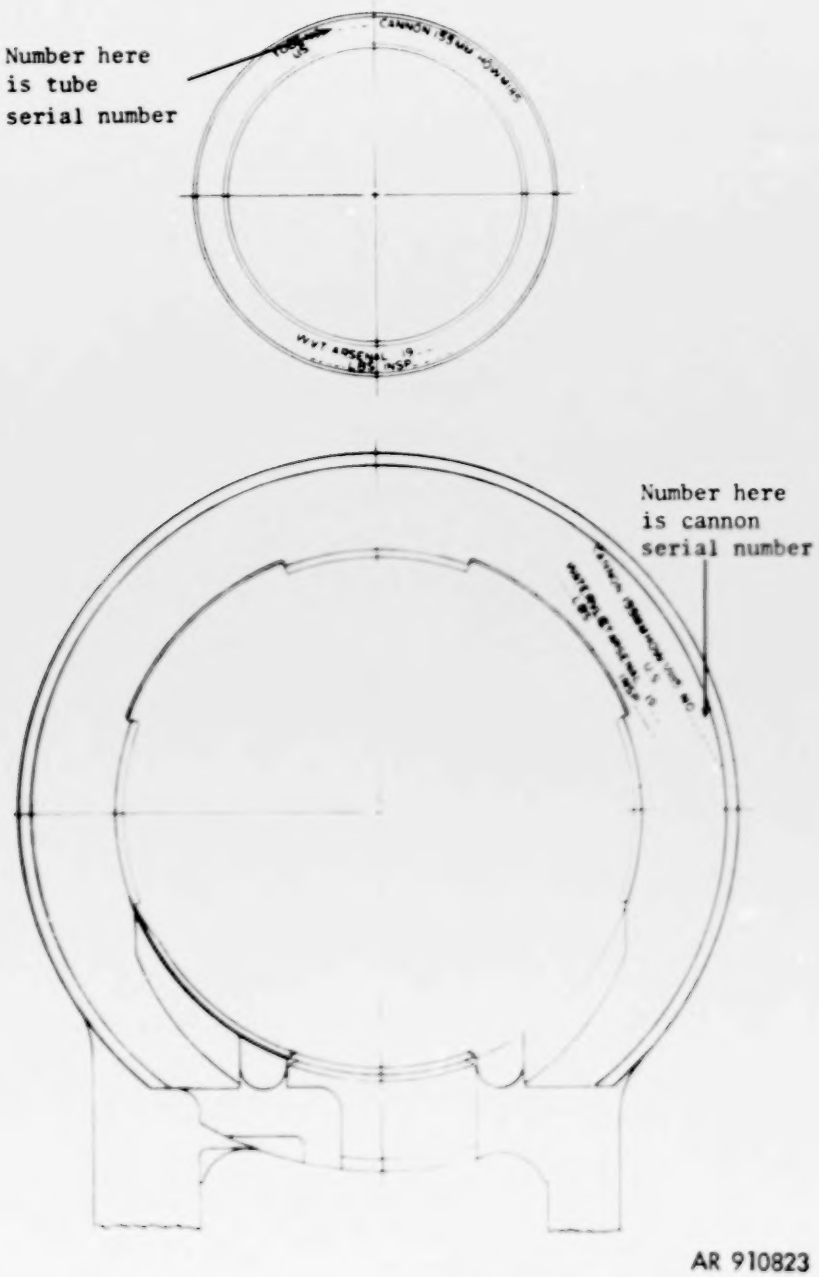


Figure 2-19. Location of tube and cannon serial number: 155-MM howitzer cannon, M185.

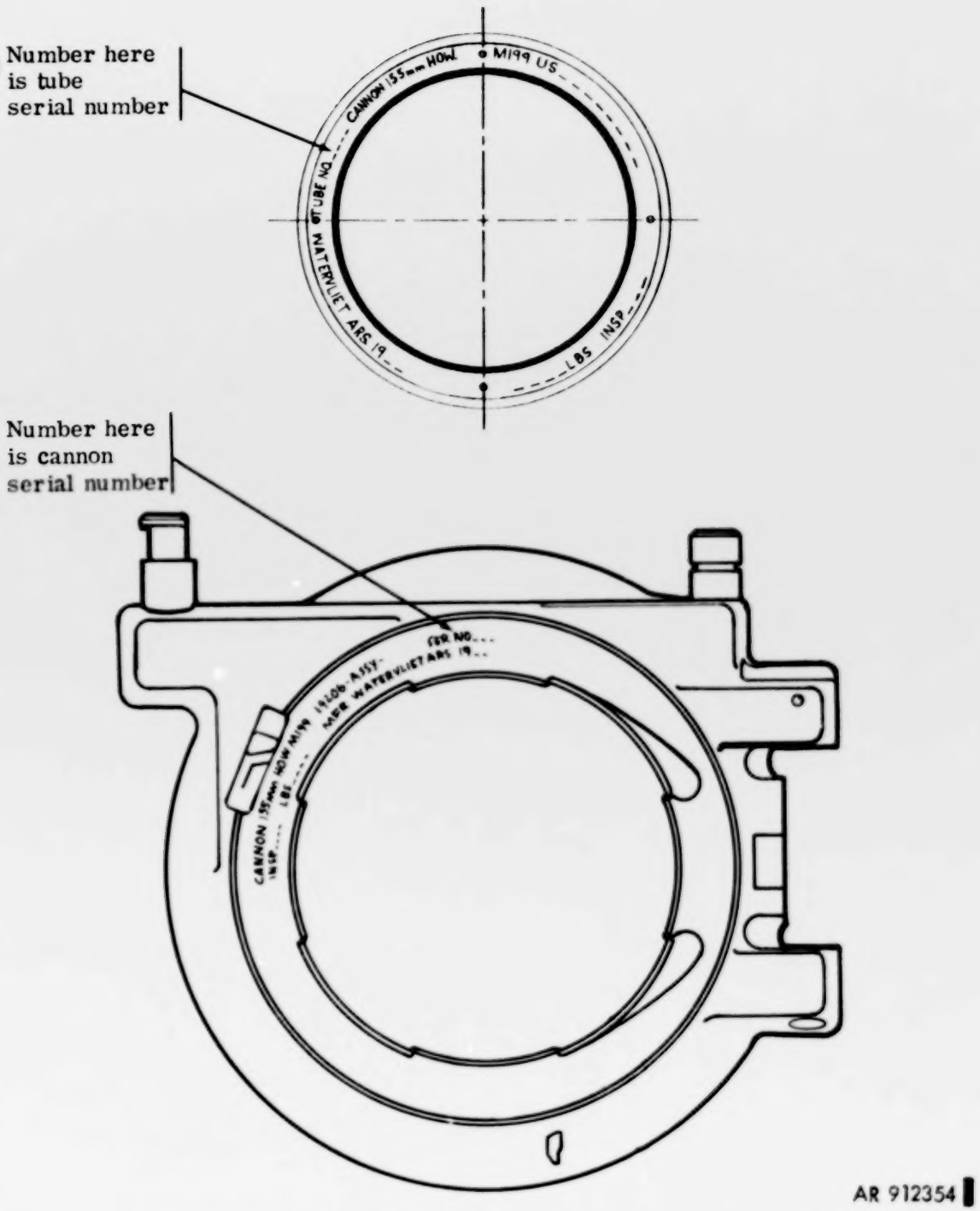


Figure 2-19.1. Location of tube and cannon serial number: 155-MM howitzer cannon, M199.

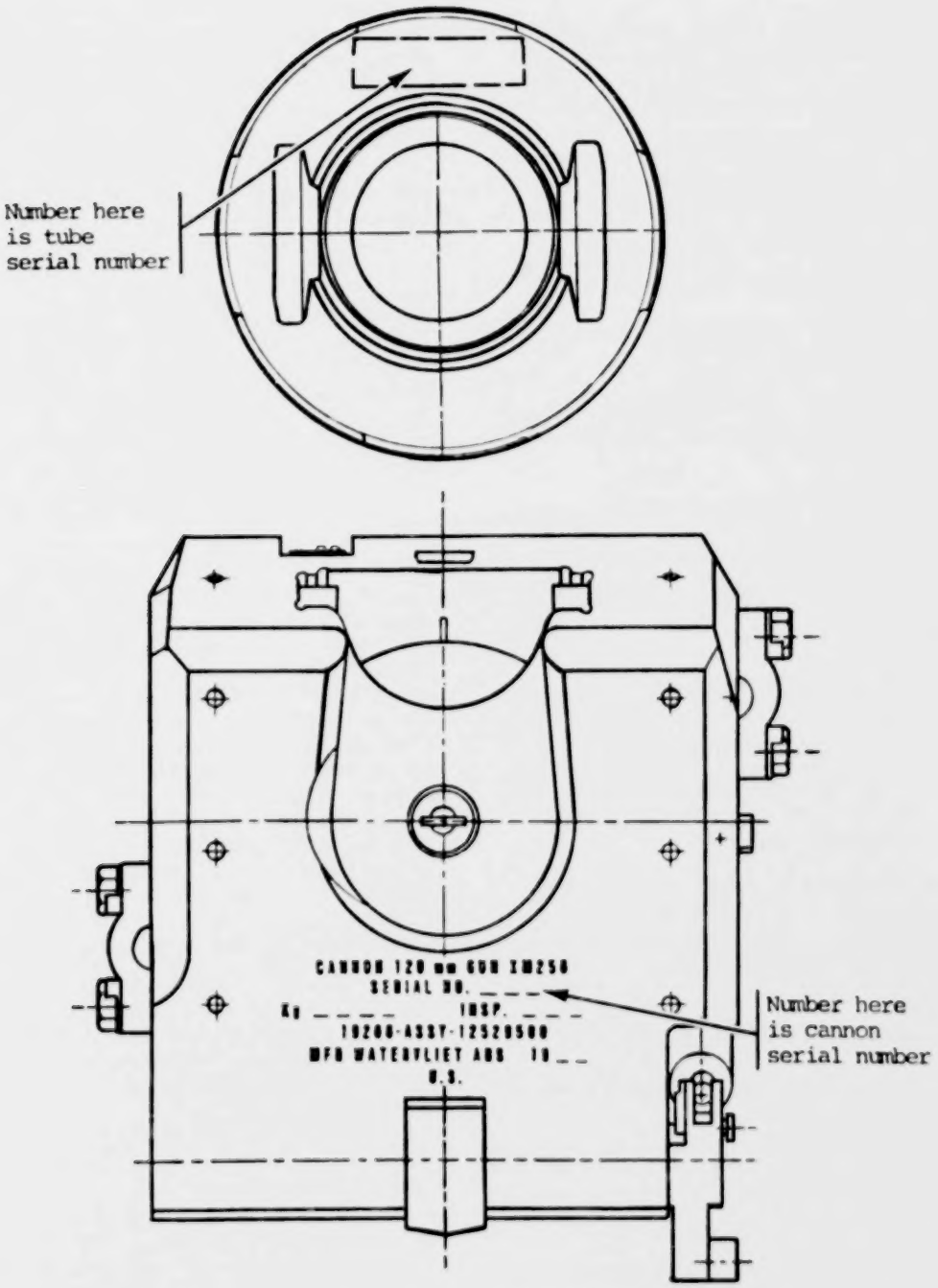


Figure 2-20. Location of tube and cannon serial number: .120mm gun cannon, M256.

2-3. Frequency of Inspection

a. When you clean tube, examine rifled and smooth areas to find any damage or erosion, in accordance with paragraphs 2-4 and 2-5.

b. Get direct support to borescope and pullover gage all tubes, according to following schedule: For 120MM M256 Tubes, use Bore Erosion Gage to measure depth of bore erosion in any location.

Within 90 days immediately preceding firing and

At other intervals when stated for specific weapons in this chapter.

NOTE: It is not necessary to observe the time (90 day) and EFC intervals for inspection separately. However, neither interval is to be exceeded without inspection.

2-4. Preparation for Visual Inspection

WARNING

Make sure that cannon and any attached spotting gun are not loaded.

a. Equipment Required. The following items are required (in addition to assembly tools and cleaning equipment listed in operator's manual):

Emery cloth 320 grit.

Flashlight or available electric lead light.

Barrel wear gage for 20-MM gun, automatic, M139.

b. Cleaning.

(1) Remove bore evacuator in accordance with disassembly instructions found in operator's weapon manual.

(2) Clean all outside tube surfaces using rifle bore cleaner. Do not use a steel brush, or abrasives other than 320 grit. Pay particular attention to keyways, teeth, and threads.

(3) Clean the bore of the tube using the specified bore brush for the tube and CLP. Also, clean the chamber area of the tube. Do not use abrasives or any other unauthorized cleaning materials in the bore of the tube. Make sure that all powder residue, dirt and rust have been removed. Do not try to get a bright, shiny finish in the bore. The bore of a fired tube will not look the same as a new tube. Fired gun tubes will have colored streaks or bands throughout the length of the bore. These colors may vary from a copper color to a gray/black color depending on the weapon. The 120MM M256 Tube smooth bore will exhibit varying degrees of color throughout the length of the bore, ranging from a uniform gray/black color to streaks of gray, black and/or dark brown. This is a normal occurrence and with continued firing, the colors will darken throughout the life of the tube. Use of unauthorized cleaning materials and procedures could result in tube damage which ultimately may lead to premature condemnation of the tube.

NOTE:
The loss of small amounts of chrome plate over the life of the gun tube will not affect accuracy or safety of the gun tube.

(4) Dry tube, using clean, soft, lint-free rags.

(5) Clean 152-MM gun launchers following instructions contained in preceding paragraphs, paying particular attention to the obturator seat and detent hole making sure all cleaning fluid is dried out.

(6) Before cleaning mortars, look for black powder streaks between tube and basecap. This indicates gas leakage. If you find this condition, notify direct support. DO NOT FIRE!

(7) Clean mortars using same method as for guns and howitzers. 81-MM mortars may show aluminum streaks in bore after cleaning.

2-5. Condemnation Information

Notify direct support:

a. When you find or think that there are cracks or other damages. DO NOT FIRE.

b. When tube's round life limit will be reached soon.

c. When tube cannot be fired accurately.

d. When evidence of welding is found anywhere on the tube.

NOTE

See sections II, III, and IV for additional information.

Section II. GUNS AND HOWITZERS

2-6. Procedure

Look for cannon tube model number which is stamped on tube near the tube cannon serial numbers (fig 2-1 thru 2-20). Then find your tube in table 2-1 or 2-2 and follow instructions contained therein.

Table 2-1. List of Tubes and Instructions, Tubes Which Have Life Based on Rounds Fired

Caliber	Tube model no.	Instructions
*90-MM	M41	Refer to para 2-9b
105-MM	M2A2, M49 (T96E1), M103	Refer to para 2-9c
105-MM	M137A1 (M137E1)	Refer to para 2-9c
*105-MM	M68/M68A1	Refer to para 2-9d
*120-MM	M256	Refer to para 2-9j
152-MM	M81 modified, M81E1, M162	Refer to para 2-9e
155-MM	M1, M1A1, M45, M126	Refer to para 2-9f
155-MM	M126A1 (M126E1)	Refer to para 2-9f
*155-MM	M185	Refer to para 2-9f
*8-inch	M201/M201A1	Refer to para 2-9i

Table 2-1. List of Tubes and Instructions,
Tubes Which Have Life Based on Rounds Fired--Continued

Caliber	Tube model no.	Instructions
		NOTE The paragraphs will indicate allowable tube life, ammo (zone) equivalent full charge (EFC) factors and number of times the breech can be re-tubed. With these number, you can figure remaining tube life by following instructions in paragraph 2-7. Also, when to notify direct support to inspect. If direct support inspection is not required now, make a visual inspection in accordance with paragraph 2-10. If there is no complete record of number of rounds fired, notify direct support. Where ammo model number or charge (zone) number is missing from equipment log book, assume 75% of fired rounds to have highest EFC number and 25% to have lowest EFC number for a specific cannon tube.

*These have a DUAL criteria of a limited rounds life plus an erosion life (measured during DS inspection). For weapons with DUAL life criteria, tube will be condemned for whatever criteria is reached first.

Table 2-2. List of Tubes and Instructions, Tubes Which Have Life Based on Erosion

Caliber	Tube model no.	Instructions
20-MM	M139	You should gage for erosion (para 2-9), and inspect for damages (para 2-10) every 1,000 rounds until you reach 5,000; then every 500 rounds. Notify direct support to borescope every 2,000 rounds. If accuracy becomes poor, gage and have direct support borescope.
Notify direct support to borescope and pullover gage the following tubes when the weapon manual says you should, when accuracy becomes poor, and when the following instructions say you should:		
40-MM	M2A1	Every 2,000 rounds until you reach 10,000, then every 1,000 rounds.
60-MM	M2, M19, M225	Refer to para 2-11b(1)
81-MM	M29, M29A1	Refer to para 2-11b(2)
107-MM (4.2-inch)	M30	Refer to para 2-11b(3)
120-MM	M58 (T123E1)	Every 100 EFC rounds.
155-MM	M46	Every 100 EFC rounds beginning at 500 rounds.
155-MM	M199	Borescope every 1,000 EFC rounds. Pullover gage at 1,000 EFC, 1,500 EFC and every 100 EFC rounds thereafter. With less than 10% estimated life remaining, pullover gage after every firing operation.
165-MM	M135	Borescope every 250 rounds. Pullover gage every 1,000 rounds.

NOTES

If direct support inspection is not required now, make a visual inspection in accordance with paragraph 2-10.

Chapter 3 will give the number of times the breech can be retubed.

2-7. Records and Inspection

a. Check weapon records for rounds fired. Refer to DA PAM 738-750 for how to compute estimated remaining round life. Then use EFC information from paragraph 2-9 to calculate the fired EFC rounds and the tube's estimated remaining life.

CAUTION

Check that EFC figures already in records were calculated properly and make any necessary corrections.

b. If you suspect that the number of rounds listed is not correct, notify direct support.

c. Where the number of rounds fired is recorded but the ammo model number or charge (zone) is missing, assume 75% of fired rounds to have highest EFC number and 25% to have the lowest EFC number for the specific cannon tube.

2-8. Attached Parts

NOTE

Parts attached to tube (fig 2-21) are not evaluated in this manual, except basecaps on mortars and vents on recoilless rifles. Whether mentioned here or not, all attached parts (which include such breech parts as ring, coupling, block, crank, obturator spindle, extractors, cams, keys, operating handle, receiver, buffer, vents, basecaps, plus brackets for telescope or spotting rifle) should be inspected in accordance to operator/organizational manual.

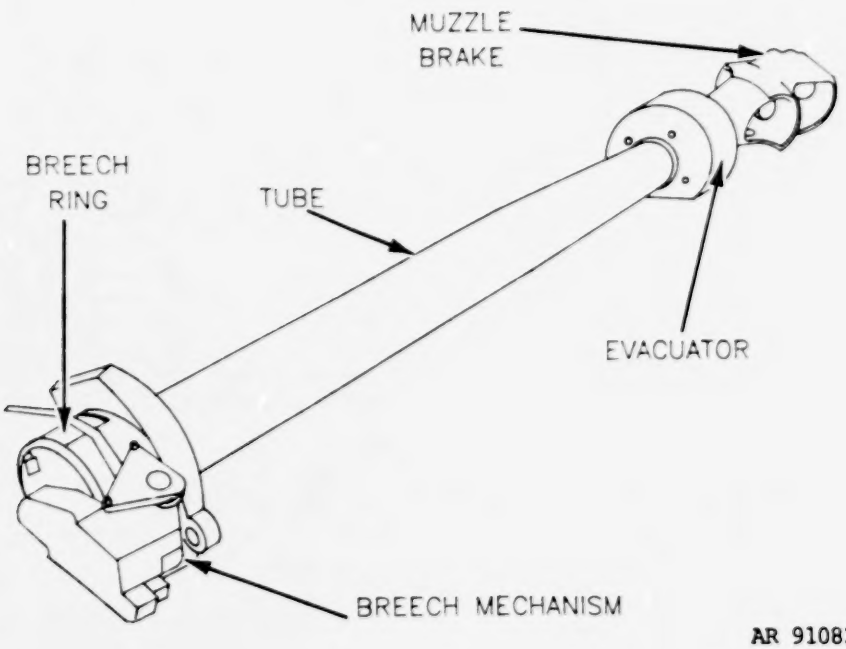


Figure 2-21. Tube and typical attached parts: guns and howitzer cannon.

2-9. Specific Weapons

a. Deleted
Figure 2-22. Deleted.
Figure 2-23. Deleted.
Figure 2-24. Deleted.

b. 90-MM Gun Cannon, M41 (U
on Tank, M48 Series).

(1) Notify direct support
borescope after every 500 roun
regardless of EFC.

Table 2-3. Deleted.

(2) After 2,000 rounds have been fired, notify direct support to borescope and to pullover gage after every additional 200 rounds, regardless of EFC.

(3) Notify direct support to inspect exterior after every 1,000 rounds, regardless of EFC. Also, to pullover gage after 1,000 M431A2 rounds have been fired and after every additional 500 of these rounds.

(4) Condemn tube at 3,000 rounds, regardless of EFC.

(5) Rounds M353A1 (type TP-T) loses accuracy after 500 rounds. Recommend using other rounds.

(6) You should expect loss of accuracy after muzzle wear of 0.020-inch (3.563-inch diam over lands). Wear (erosion) could be eccentric or spread evenly over lands.

c. 105mm howitzer cannon, M2A2, M49 (T96E1), M103, and M137A1 (M137E1). (If M137A1 total cumulative round count exceeds 10,000 rounds, turn-in cannon tube for inspection by depot level personnel. Extensions of 2,000 more cumulative rounds may be given by depot level personnel. Further extensions may be given every 2,000 additional cumulative rounds.) Refer to table 2-4.

Table 2-4. Life of Cannon Tube Based on EFC Round Count on 105-MM Howitzer Cannon: M2A2, M49 (T96E1), M103, and M137A1 (M137E1)

Tube model	Major item	EFC round life of tube	EFC factors	Breech life
M2A2	Howitzer M101 and M101A1	7,500 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and 2 tubes
M49 (T96E1)	Howitzer M52 and M52A1	7,500 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and 4 tubes
M103*	Howitzer M108	3,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and 3 tubes
M137A1** (M137E1)	Howitzer M102	5,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.10	Original and 3 tubes

*M103 Tube: After firing 1,000 EFC rounds, notify direct support after each 100 rounds (regardless of EFC) to inspect muzzle keyways and external bore evacuator holes. After 2,000 EFC rounds, do this after each 50 rounds (regardless of EFC).

**M137A1: Ammo M546 (Beehive): EFC = 1.0 regardless of zone fired.

d. 105-MM Gun Cannon, M68/M68A1 (Used on Tank, M48 and M60 Series, and M1).

(1) Have direct support borescope and pullover gage the gun tube as specified in paragraph 2-3b. Additionally, the interval between pullover gage measurement and borescope inspection is not to exceed 200 EFC rounds. Information carried forward to each new DA Form 2408-4 is to include the EFC rounds remaining at the last pullover gage measurement and borescope inspection.

(2) In order to eliminate redundant inspection intervals; i.e., compliance with 90 day pullover gaging/borescope requirement with 150 EFC rounds expended followed by reinspection at the 200 EFC round interval is unnecessary; cumulative totals may be applied; i.e., 150 EFC rounds followed by subsequent inspection at 350 EFC rounds. This criteria complies with reflected EFC round count intervals.

(3) WP and HEP-type ammunitions (M416, M467, and M393 series) have EFC factors of 0.5. All other ammunition has an EFC factor of 1.0. These EFC factors apply to ammunition fired at ambient temperatures of 105°F (40.6°C) or below. When fired at ambient temperatures above 105°F (40.6°C), the EFC factor is doubled for each round.

(4) Have direct support condemn the gun tube after firing 1000 EFC rounds.

(5) This cannon tube is inspected and condemned under dual criteria which require exact computation and recording of the EFC rounds remaining.

e. 152-MM Gun Launcher, M81 Modified, M81E1, and M162. Refer to table 2-5.

Table 2-5. Life of Tube Based on EFC Round Count on 152-MM Gun Launcher, M81 Modified, and M81E1

Major item	Gun launcher model	EFC round life of tube	EFC round life coupling	EFC round life chamber
Sheridan M551 and M551A1	M81 Modified	600	1200	600
Sheridan M551 and M551A1	M81E1	800	1600	800

All ammo has an EFC of 1.0 when fired at 105°F or below outside air temperature, an EFC of 2.0 above 105°F.

Missile has an EFC of zero (no limit).

NOTES

In this weapon, the breech ring is called "coupling".

Coupling is reused once on the Sheridan.

On Sheridan M551 and M551A1, cannon pressure vessel consists of: Gun tube, chamber, obturator seal, and detent assembly.

f. 155-MM Howitzer Cannon, M1, M1A1, M1A2, M45, M126, M126A1 (M126E1), and M185 (Table 2-6).

(1) Have direct support borescope the following tube types after the indicated number of EFC rounds have been fired:

Tube Type	
M1	After every 1,000 EFC rounds
M1A1/M1A2	After every 2,500 EFC rounds
M45	After every 2,500 EFC rounds
M126	After every 2,000 EFC rounds
M126A1 (M126E1)	After every 2,000 EFC rounds
M185	After every 1,000 EFC rounds

(2) After 4,000 EFC rounds have been fired by an M185 tube, have direct support borescope and pull-over gage after every additional 500 EFC rounds have been fired.

Table 2-6. Life of Cannon Tube Based on EFC Round Count on 155-MM Howitzer Cannon, M1, M1A1, M1A2, M45, M126, M126A1 (M126E1), and M185

Tube model	Major item	EFC round life of tube	EFC factors	Breech life
M1	Howitzer M114 and M114A1	2,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	No retubing
M1A1/ M1A2	Howitzer M114 M114A1, M114A2, M123A1	7,500 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	No retubing
M45	Howitzer M44 and M44A1	5,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	No retubing
M126	Howitzer M109	5,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and 2 tubes
M126A1 (M126E1)	Howitzer M109	7,500 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and 2 tubes
M185 (see page 3-19)	Howitzer M109A1/A2/A3	6,375 rounds	Zone 8 = 1.00 Zone 7 = 0.75 Zone 1-6 = 0.25	Original and 2 tubes

g. Deleted.

h. Deleted.

i. 8-Inch Howitzer Cannon, M201/M201A1.

(1) Have direct support borescope and pullover gage every 1,000 EFC rounds.

(2) Condemn tube at 10,000 EFC rounds or 0.135 wear, whichever comes first.

(3) Breech may be rebushed four times.

j. 120-mm Gun Cannon, M256.

(1) Have Direct Support borescope the gun tube as specified in Para 2-3. Depth of bore erosion into the tube base metal shall be measured with the Bore Erosion Depth Gage (P/N 12520840). In addition to the interval specified in Para 2-3, the borescope and erosion depth measurement interval is not to exceed 150 rounds. The information carried forward on each new DA Form 2408-4 is to include the EFC rounds remaining, a description of extent and location of heaviest pitting and/or chrome loss, the depth and location of eroded areas, at the last bore erosion depth measurement and borescope inspection.

NOTE:
The loss of small amounts of chrome plate over the life of the gun tube will not affect accuracy or safety of the gun tube.

(2) This cannon is inspected and condemned under a dual inspection criteria. Have Direct Support condemn the tube when 750 EFC rounds have been fired or the depth of bore erosion reaches 5MM. All rounds have an EFC factor of 1.0.

(3) The breech mechanism assembly shall be replaced at 4500 EFC rounds.

All data on page 2-33, including
Table 2-7 and Table 2-8 deleted.

2-10. Visual Inspection and Criteria for Various Types of Damage

Use illustrations and following information to aid you in making decisions:

a. Eyeball tube's exterior for cracks, gouges, bulges, dents, gas leaks. Check edges of keyways for cracks.

b. Eyeball, carefully, as much of bore as you can see with aid of a flashlight or electric lead light. (This will not be as much as direct support would see with tneir borescope.)

c. Look for cracks and other internal damages which may have been caused by dirty ammo, overheating, not being cleaned, careless handling, leaving something in the bore, or by hostile fire. Pay special attention to origin of rifling area (breech end).

d. If you see any cracks or anything else that is serious or suspicious, notify direct support.

e. If gas leakage from the breech chamber is not cured by using a new obturator pad or split rings, notify direct support.

f. If case is hard to extract from chamber, notify direct support.

g. If found, the following damages are *not* critical:

(1) External gouges less than 1/4-inch deep (fig 2-25 and 2-26).

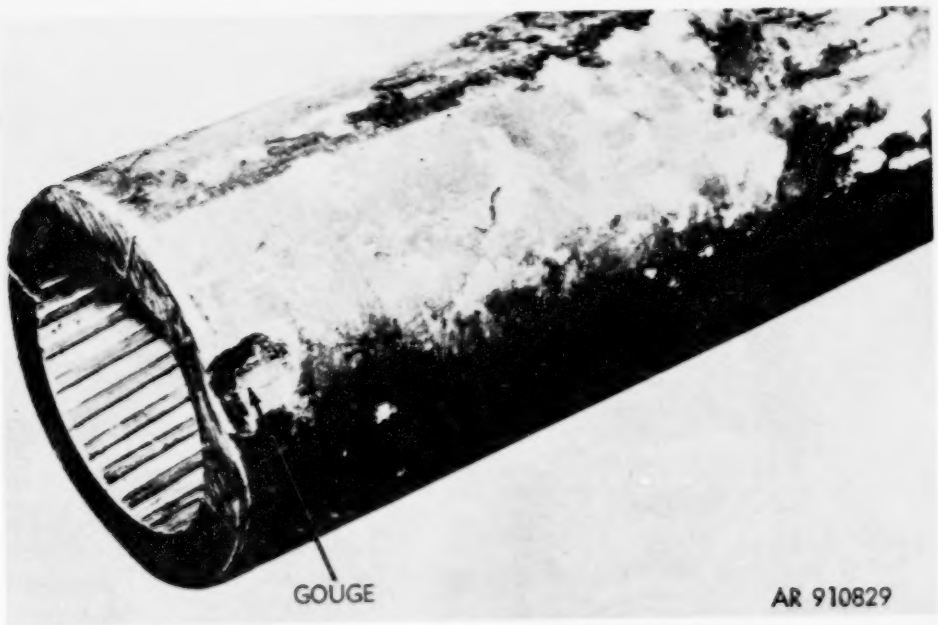


Figure 2-25. External Gouge--outside.

Figure 2-26. External gouge-end.

(2) Pitting in the Chamber.

(a) Under 155-MM size: If pits cover less than 20% of the entire chamber surface.

(b) 155-MM size and up: No limit to depth or area.

(3) Pits on recoil slide surface (when uncovered). If pits cover less than the area or depth shown in table 2-9.

(4) Pits on surfaces under bore evacuator (fig 2-27 and 2-28). If pits cover less than area or depth stated in table 2-10.

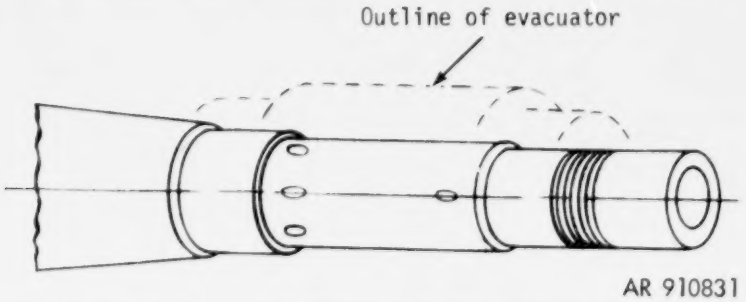


Figure 2-27. Surfaces under bore evacuator.

Figure 2-28. Pitting under bore evacuator: 105-MM gun cannon, M68.

Table 2-9. Pits on Recoil Slide Surfaces

Tube	Depth	Total slide surface area
75-MM, 76-MM, 90-MM, 105-MM Howitzer only	0.015-inch or	20%
105-MM Gun, M68/M68A1	0.020-inch or	50%
120-MM, M256	0.020-inch (0.51-mm) or	80%
152-MM, 155-MM	Ignore pitting	Ignore pitting

(5) Rust that can be removed by using 320, or finer, emery cloth so that it will not conceal a crack or deep pit.

(6) Burrs and upset metal that can be removed by using 320, or finer, emery cloth.

(7) Copper colored areas in tube.

(8) Damage to lands in the 155-MM, M185 Tube often is found in the area up to 10 inches forward of the origin of rifling. Damage of this type, shown in figures 3-27 and 3-27.1, is not cause for condemnation.

h. Give careful attention to the following 152-MM gun launcher areas:

(1) Obturator seat and cavity.

(a) Clean seat and cavity using rifle bore cleaner and a non-scratching brush, pad, or cloth. (Do not use any abrasive material).

(b) If you see burrs, scratches, gouges, galling, erosion, pitting, upset metal, non-removable rust or carbon, notify direct support.

(c) The seal requires use of an offset screwdriver for removal. If present seal or the replacement cannot be retained in tube, notify direct support.

(2) Scavenger hole seat. If check valve leaks during firing, the mating tube surface probably is worn. Notify direct support.

(3) Ammo detent hole. If smoke discharges from tube lock key or ammo detent vent during firing, notify direct support.

Table 2-10. Pits on Surfaces Below Bore Evacuator

	Nonbearing surface		Bearing under each end
Tube	Depth at any one or more locations	Total area	Area each end
105-MM Howitzer, M103	0.040-inch	90%	0.020 inch deep or 20%
105-MM Gun, M68/M68A1	0.125-inch	80%	If you see no gas leakage during firing, powder streaks, or gas erosion path.
90-MM Gun, M41	0.040-inch	80%	If you see no gas leakage during firing, powder streaks, or gas erosion path.
120-MM Gun, M58 (T123E1)	0.040-inch	80%	If you see no gas leakage during firing, powder streaks, or gas erosion path.
120-MM Gun, M256	0.040-inch	80%	If you see no gas leakage during firing, powder streaks, or gas erosion path.
152-MM Gun Launcher	Ignore pitting		
155-MM Guns & Howitzers	Ignore pitting		

Section III. MORTARS

2-11. Frequency of Inspection: Special

a. After three consecutive or intermittent short rounds, check that exact number of charges and correct firing tables were used and that mortar was correctly laid. If everthing was done correctly, then, if possible, fire ammo from the same lot in another mortar to compare results. If rounds perform properly in the other weapon/s, then request complete inspection of the first cannon tube by Direct Support Maintenance.

b. Have direct support borescope and pullover gage the following types of mortars at the indicated frequencies:

(1) 60-MM mortar, M2, M19, and M224. After every additional 1,000 rounds once 10,000 rounds have been fired or when bore reaches 2.402-inch diameter.

(2) 81-MM mortar, M29, M29A1, and M252. If you find any annular rings worn on bore near breech end (fig 2-29), or after every additional 500 rounds once 5000 rounds have been fired.

(3) 4.2-inch mortar, M30. After every additional 500 rounds once 4,000 rounds have been fired.

Figure 2-29. Erosion rings in 81-MM mortar.

2-12. Visual Inspection and Criteria for Various Types of Damage

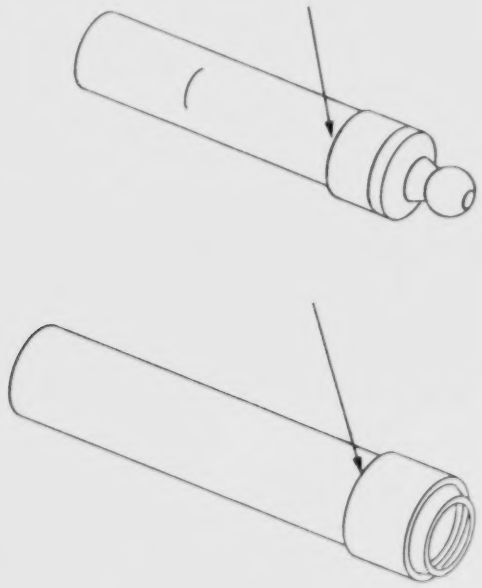
WARNING

When damage is serious or uncertain, DO NOT FIRE. Notify direct support immediately.

a. Notify direct support when following damages are found:

(1) Evidence of gas leakage before and after cleaning (indicated by black streaks or erosion of metal) and for looseness at basecap joint (fig 2-30) of M2 and M224.

(2) If a loose M19 basecap cannot be tightened up to effect a gas tight seal.



AR 910834

Figure 2-30. Tube and basecap joint: 60-MM mortar, M2, M19, and M224.

(3) Crack (or suspicion of it) on tube or basecap.

(4) Visible bulges, dents, or out-of-roundness.

(5) Internal pits or scores larger than 3/8-inch and over 0.010-inch deep. Check any aluminum colored streaks or scores (fig 2-31).

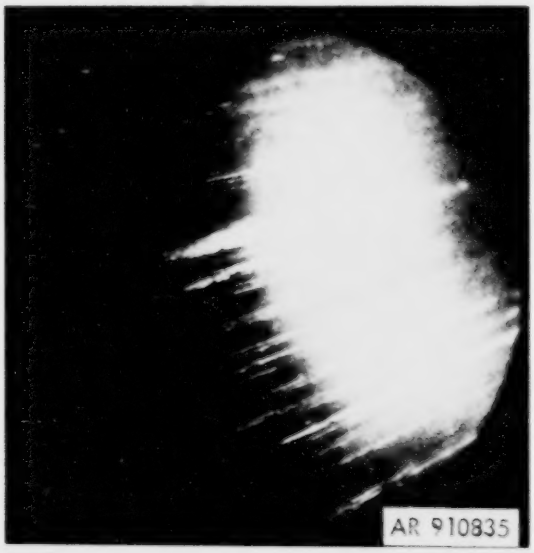


Figure 2-31. Aluminum streaks in smooth bore mortar: ACCEPTABLE.

(6) Bent basecap or immovable firing pin.

(7) Erosion on 60-MM and 81-MM mortars basecap around firing pin that results from firing of 22 subcaliber sabot training rounds. Erosion in excess of 0.125 is cause for condemnation. Note that the basecap can be replaced on the lightweight 60-MM cannon, M225.

b. Remove upset metal from shallow scores by using 320, or finer emery cloth.

Section IV. RECOILLESS RIFLES

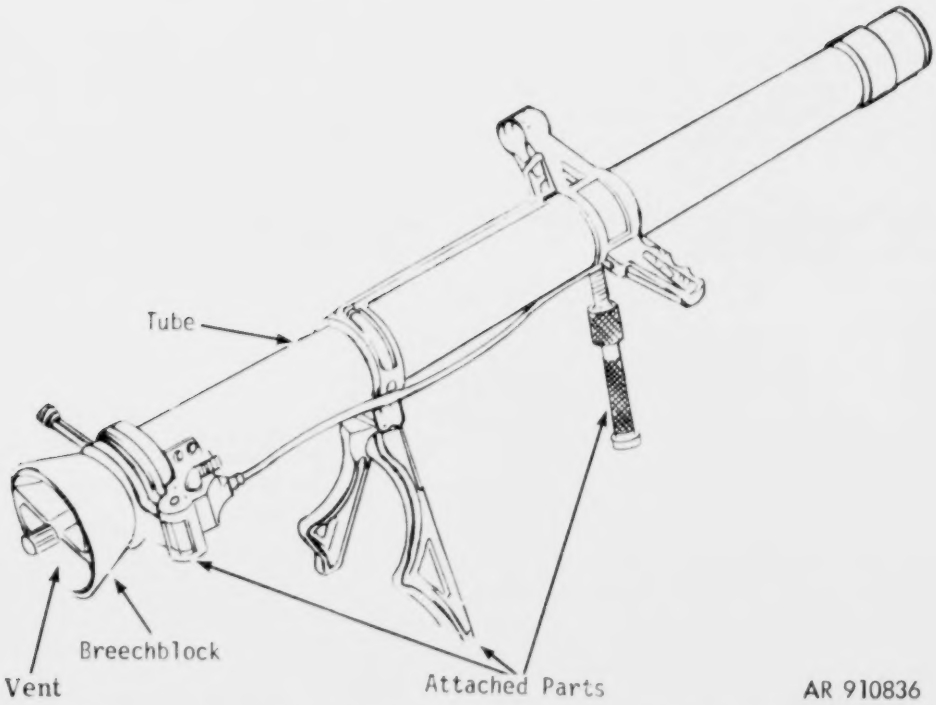


Figure 2-32. Tube, breechblock, vent and attached parts: 90-MM recoilless rifle, M67.

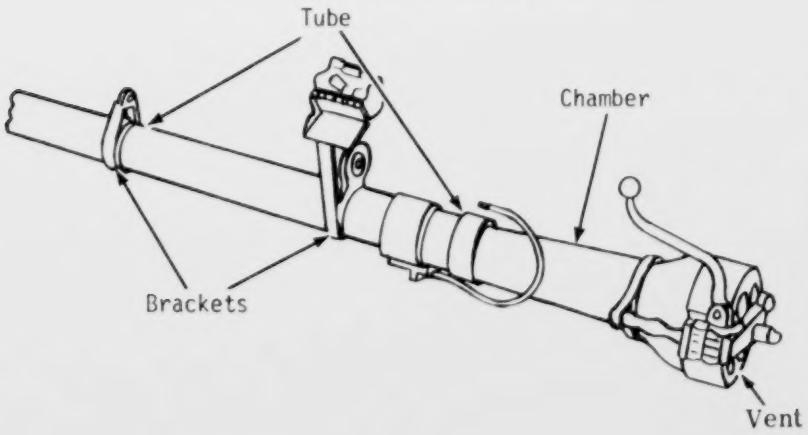


Figure 2-33. Tube, chamber, vent and attached parts: 106-MM recoilless rifle, M40 series.

2-13. General

In addition to damage criteria, tubes have other life criteria such as number of rounds fired, inability to balance, ellipticity of bore, and erosion of vent.

2-14. Visual Inspection and Criteria for Various Types of Damage

a. Notify direct support if you are uncertain as to seriousness of any damage.

b. Notify direct support if they haven't inspected weapon for over a year.

c. Notify direct support when the following conditions are found.

(1) Visible dents or out-of-roundness.

(2) Visible bulges.

(3) Exterior gouges.

(4) Cracks anywhere on tube or breechblock (fig 2-34).

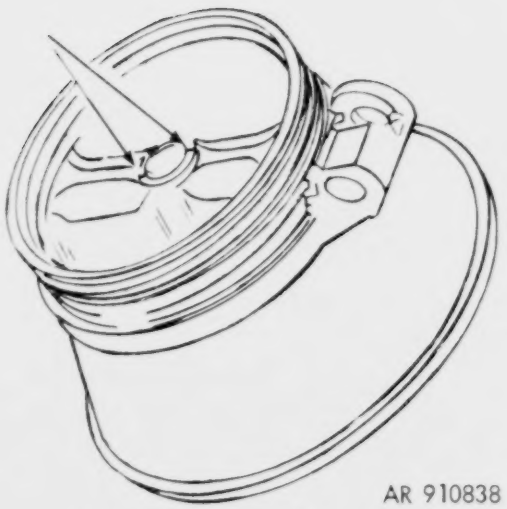


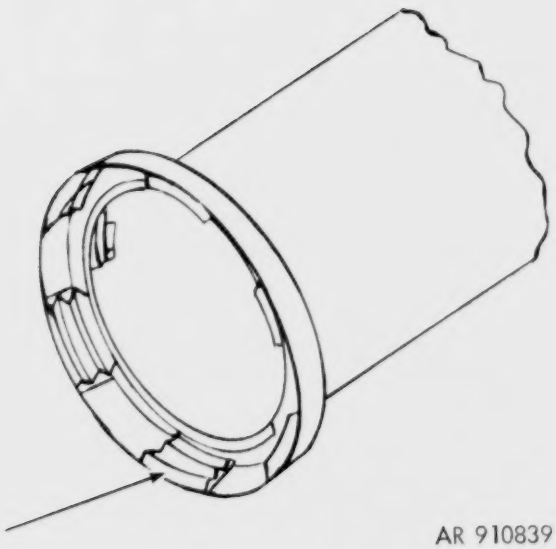
Figure 2-34. Cracks in breechblock hole for hammer bushing: 90-MM recoilless rifle, M67.

(5) Erosion in the bore.

(6) A missing land.

(7) Internal pits or scores over 3/8-inch long and over 0.010-inch deep. Also, stripped or spalled groove between lands.

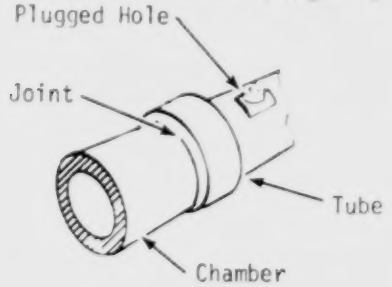
(8) Cracked or badly worn interrupted threads on breech end of a 90-MM recoilless rifle (fig 2-35).



AR 910839

Figure 2-35. Breech threads on tube: 90-MM recoilless rifle, M67.

(9) Evidence of gas leakage at chamber-tube joint or at plugged hole for round indicator of a 106-MM recoilless rifle (fig 2-36).



AR 910840

Figure 2-36. Plugged hole for round indicator: tube chamber joint: 106-MM recoilless rifle, M40 series.

(10) Damaged or misaligned telescope or spotting gun brackets of a 106-MM recoilless rifle.

(11) If 106-MM recoilless rifle alignment marks at connection of tube and chamber (fig 2-37) are not mated.

(12) When tube reaches either of criteria listed in table 2-11, check log book and any stampings on tube regarding vent installed.

(13) If rounds fired information is incomplete and "additional condemning limits" criteria in table 2-11 has not been reached.

(14) If number of rounds fired are unknown.

(15) When you need to adjust or replace the vent but neither the rifle's markings nor the weapon records indicates which vent is installed.

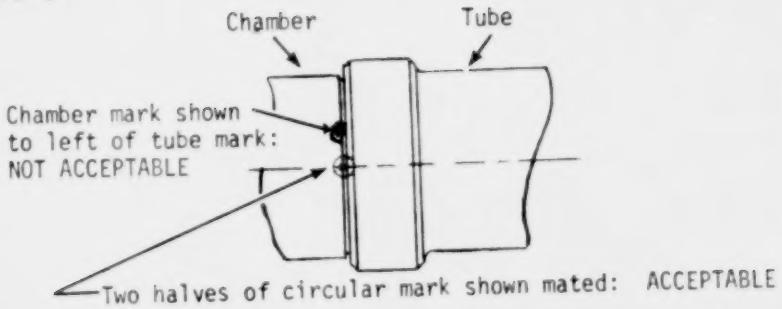

Chamber
Tube
Chamber mark shown to left of tube mark: NOT ACCEPTABLE
Two halves of circular mark shown mated: ACCEPTABLE
AR 910841

Figure 2-37. Alignment mark at tube chamber joint: 106-MM recoilless rifle, M40 series.

Table 2-11. Condemning Limits for Tube and Breechblock of Recoilless Rifles.

Caliber	Model no.	Condemnation round life	Additional condemnation limits
57-MM	M18, M18A1 T15E16	2,500	Inability to balance weapon with a +10 throat ring. (Unbalance is when forward movement is strong enough to cause inaccurate firing.) (Weapon has 5 throat ring sets. Each set has a life of approximately 500 rounds.)
75-MM	M20, T21E12	2,000	Inability to balance weapon with 4th vent bushing. Four bushings are the limit. (Unbalance is when forward movement is strong enough to cause inaccurate firing.)
90-MM	M67, T219E4	2,000	Rifle is unbalanced. Unbalance is when forward movement is strong enough to cause inaccurate firing.)
106-MM	M40 Series	*3,000	None.

NOTE

All rounds have an EFC factor of 1.0.

Balance weapon by adjusting or replacing vent in accordance with instructions in operator's manual.

*If tube is condemned but its vent has fired under 500 rounds, notify direct support that the nozzle can be used with another tube.

CHAPTER 3
INSPECTION BY DIRECT SUPPORT AND GENERAL SUPPORT PERSONNEL

Section 1. GENERAL

3-1. Reason for Inspection

WARNING

Defective tube may endanger lives of personnel by exploding or by inaccurate firing.

Carefully inspect tube to find any damage or too much wear. With information in this manual, you can decide if tube can be used, condemned, or sent to depot for overhaul.

3-2. Types of Inspection

a. Records Inspection. Get the following information from equipment log book to help in figuring estimated remaining life:

(1) Number of rounds fired, and with what type projectiles or charges.

(2) Marking of breech when a new tube is installed.

(3) Markings of vent number or adjustment on cetain recoilless rifles.

b. Missing Records. If there is no complete record of number of rounds fired, proceed as follows:

(1) Borescope tube--If you don't condemn tube because of damage, continue inspecting.

(2) Take a pullover gage reading on all tubes except gun launchers, M81 modified, M81E1 and M162 and M256. If you don't condemn tube based on its wear limit (table 2-1), obtain comments (if possible) regarding accuracy of firing.

(3) For the 120MM M256 tube, borescope the tube and note the general condition of the tube bore surface. When a tube shows pitting and/or chrome plate loss, report whether the condition is light, moderate or heavy along with the location of the predominant area in which it occurs as measured from the muzzle end of the tube. State whether the condition occurs generally throughout the bore. Examples of light, moderate or heavy pitting, chipping, stripping of chrome and bore erosion are shown in photographs illustrated by Figures 3-67 through 3-70.6 which start on page 3-119. If bore surface erosion occurs into the base metal where chrome plating has been lost, as shown on Figures 3-70.5, and 3-70.6, measure the maximum depth of erosion in these areas. Use the Bore Erosion Gage, P/N 12520840. Report the estimated length and width and location of eroded areas. Locations should be specified by distances from the muzzle end and by the clock locations as viewed from the muzzle end. Refer to DA PAM 738-750 for directions as to where to record the above information on DA Form 2408-4 Weapon Record Card.

NOTE:

The loss of small amounts of chrome plate over the life of the gun tube will not affect accuracy or safety of the gun tube.

(4) Send copies of record, along with pullover gage readings, serial numbers of tube, breech ring, and weapon, plus any known history to: Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000.

c. Visual Inspection. Includes use of following equipment:

(1) Borescope. Use it to find damages in bore and chamber. It is a telescope with a lighted mirror to give a close-up view. See TM 9-6650-235-13&P for instructions on how to select and use it.

NOTE

End views alone of bore are not clear enough to make proper decisions on how critical damage or wear is. Look at mirror of borescope to get a direct view down on tube wall. Do this along entire length of tube, including chamber. View a suspected defect at different angles by moving borescope slightly.

(2) Pullover gage. You determine wear of a rifled tube bore by using a pullover gage which measure diameter across lands or a smooth bore at the axial location stated in paragraph 3-8 pertaining to the specific weapon. See TM 9-4933-258-13&P for instructions on how to select and use it.

(3) For 120MM M256 tubes, smooth bore, you determine erosion depth with a Bore Erosion Gage (P/N 12520840) which attaches to the standard borescope. A maximum depth of existing erosion in any area of the tube should be measured and recorded. See TM 9-2350-264-34-2-2 for instructions on how to use the gage.

(4) Special equipment. See paragraph 3-8 pertaining to specific weapons.

d. Difficult Inspection. When damage is unique and difficult to analyze, take photographs of damage and forward the photos with pullover gage readings. In the case of the 120MM M256, take photos of the damaged areas and forward along with borescope inspection notations and bore erosion depth measurements. Bore erosion depth is measured with a Bore Erosion Gage (P/N 12520840). A Polaroid Camera for photographing unique or difficult to describe conditions may be obtained by contacting the AMCCOM Logistics Assistance Representative. The above information, along with DA Form 2408-4 Weapon Record Data Card should be forwarded to: Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000, for a decision. DO NOT fire weapon.

3-3. Frequency of Inspection

Inspect all tubes in accordance with following frequency, using equipment mentioned in paragraph 3-2, and measure tube bores (using a pullover gage or the Bore Erosion Gage, P/N 12520840) having wear criteria:

When organizational personnel requests you to.

Within 90 days immediately preceding firing.

At other intervals when stated for specific weapons in this chapter.

NOTE: It is not necessary to observe the time (90 days) and EFC interval for inspections separately. However, neither interval is to be exceeded without inspection.

When troubleshooting indicates you should.

When a tube is installed (even if it is new).

If you are uncertain as to whether or not tube was inspected.

3-4. Preparation for Inspection

WARNING

Make sure that cannon, and any attached spotting gun, are not loaded.

a. Equipment Required.

See table 3-1 for items required (in addition to assembly tools and cleaning equipment listed in direct support manual for each weapon).

Table 3-1. Special Tools and Equipment

Item #	NSN	Nomenclature
1		Borescope: See TM 9-6650-235-13&P for size and NSN.
2		Pullover Gage: See TM 9-4933-258-13&P for size and NSN.
3	1315-00-684-3051	Dummy cartridge, 106-MM, M368: See TM 9-1015-221-12 (May 87), SB 700-20, Chap. 8 (LIN #G73975).
4	5210-00-476-8801	Radius gage: For 90-MM recoilless rifle, M67 (fig 3-1).
5		
6	4933-00-006-4092	Inspection Kit: For detent hole of 152-MM gun launcher, M81, M81E1, M162.
7	5110-00-289-0002	Die Set, 1/8-Inch: For stamping numbers on breech rings.
8	5350-00-246-0330	Cloth, abrasive, aluminum oxide, 320 grit, jean backed: See GSA Supply Catalog NOTE: Do not use abrasives coarser than 320 grit. Never use a steel (wire) brush.
9	8010-00-551-0128	Pigment, iron blue.
10	6520-00-557-7015	Dental Artificial Stone (VEL-MIX STONE).
11		Aluminum Tubing: 2-inch diameter.
12	5210-01-280-5223	Bore Erosion Gage: For 120-MM M256 Tube

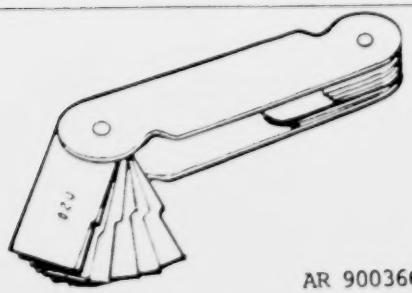


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Figure 3-1. Fillet and radius gage: 90-MM recoilless rifle, M67.

b. Cleaning.

Clean bore, chamber, and exterior of cannon tube thoroughly (according to instructions in the weapon manual) and dry them prior to inspection. Do not attempt to obtain a bright finish. A properly cleaned bore is normally uniformly light grey in color. After cleaning, guns and howitzers may show copper color streaks but 81-MM mortars may show aluminum streaks.

Section II. GUNS, HOWITZERS AND GUN LAUNCHERS

3-5. Procedure

a. Look for tube model number which is stamped on the tube (fig 2-1 through 2-20).

b. Find your tube.

c. If its life is figured on rounds fired, verify estimated remaining life figure sent you by weapon operator, using following method:

(1) See paragraph referred to in table 2-1. It will give you allowable tube life, ammo (zone) EFC factor, and when to borescope bore.

(2) Refer to DA PAM 738-750 for instructions on how to compute estimated remaining life and for log book entry. Figure estimated remaining life by using tube and ammo EFC figures. Verify accuracy of calculations already made in log book. Where ammo model number or charge (zone) number is missing from equipment log book, assume 75% of fired rounds to have highest EFC number and 25% to have lowest EFC number for a specific cannon tube.

d. If you don't condemn this tube now, inspect exterior. If satisfactory, borescope interior (para 3-9). Condemn tube if any evidence of welding is found. This includes all guns, howitzers, guns/launchers, recoilless rifles, and mortars.

e. If tube life is figured on erosion, inspect exterior (para 3-9). If satisfactory, pullover gage it and find estimated remaining life in the specific table for your tube (para 3-8). Then borescope tube (para 3-9). Condemn if required.

f. If you condemn a tube for any reason, see paragraph 3-7 to figure out whether breech ring can be retubed. Either retube or condemn breech ring and attached parts (para 3-7).

g. 20-MM gun automatic, M139--Measure tube (barrel) for erosion and determine if gun should be retubed (para 2-9). If you don't condemn it, borescope tube (para 3-9).

3-6. Sample of Use of EFC (Effective Full Charge) Figures

To determine how many rounds of a certain model ammo or zone charge can be fired, divide EFC rounds in estimated rounds life column by EFC number of specific round or zone. For example, in table 3-6 where wear reading shows estimated remaining life of 15% (EFC of 105), divide 105 by the 0.24 EFC (for "normal" zone), resulting in an estimated figure of 437 "normal" rounds or zone charges that can be fired before tube is completely worn out.

3-7. Attached Parts

a. Breech Ring: Retubing and Marking (Except 105-MM M68/M68A1 and 120-MM M256 Cannon).

(1) Determine number of times breech ring has been retubed by looking at equipment log book and the stamping on ring. (Figure 3-2 shows the stamping location). On ring, lowest number which has not been cancelled tells number of times ring has been retubed. If equipment log book and stamping do not show same number of retubings, use the higher figure. Compare figure used with number of allowable retubings indicated in paragraph 2-9 or 3-8.

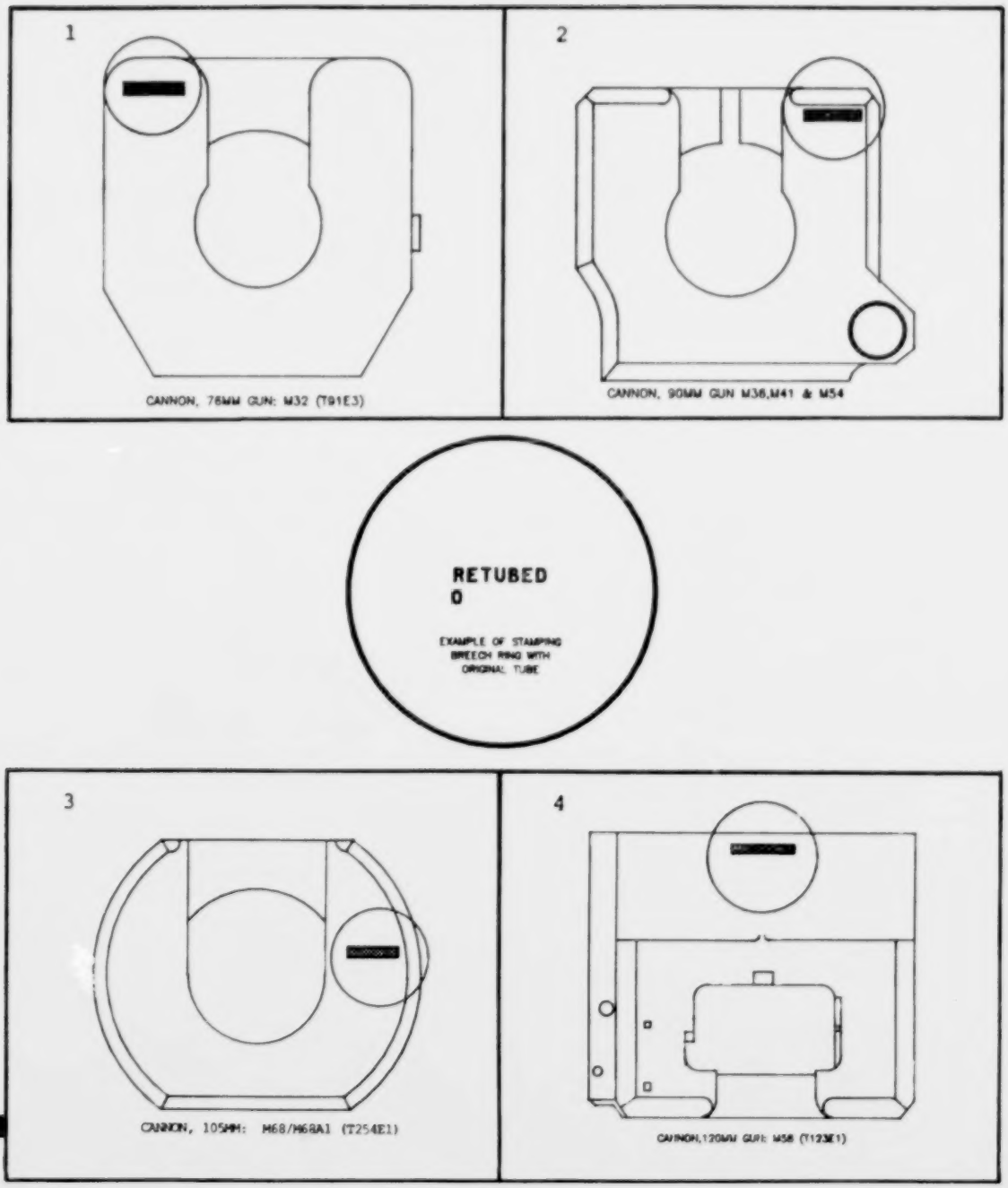
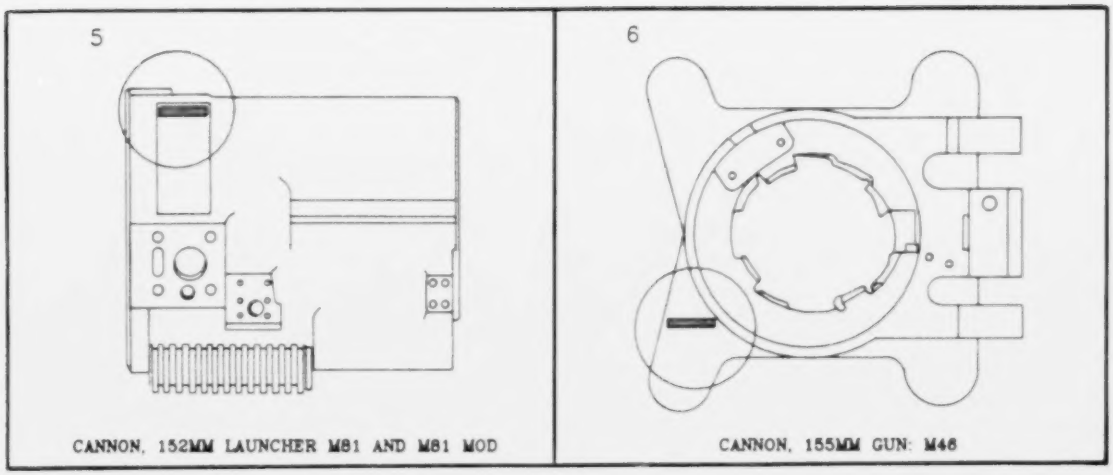
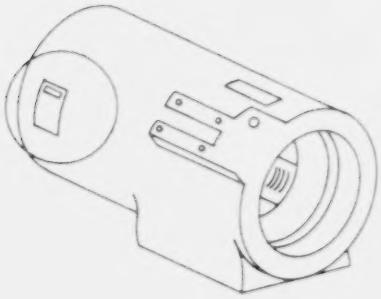


Figure 3-2. Location of identifying number of retubings (1 of 3).





CANNON, 152MM GUN LAUNCHER: M162

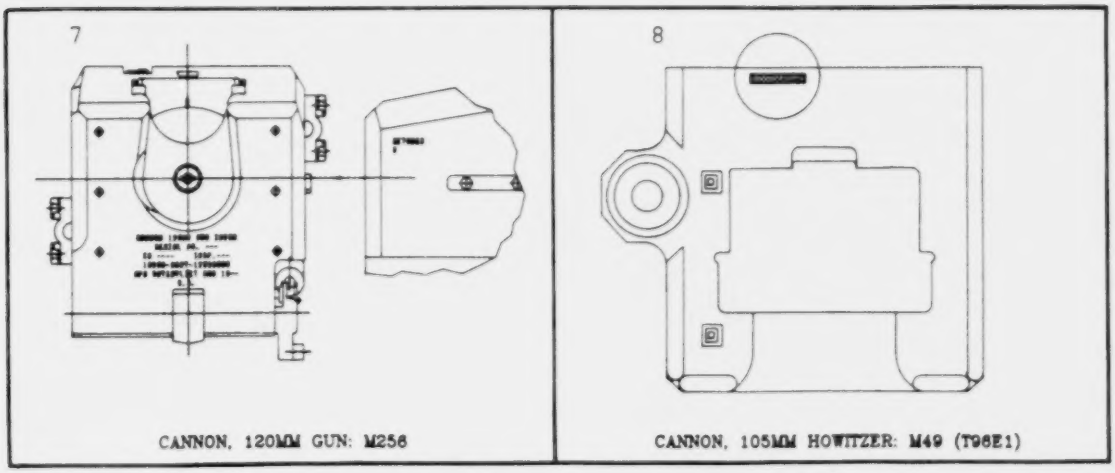


Figure 3-2. Location of identifying number of retubings (2 of 3).

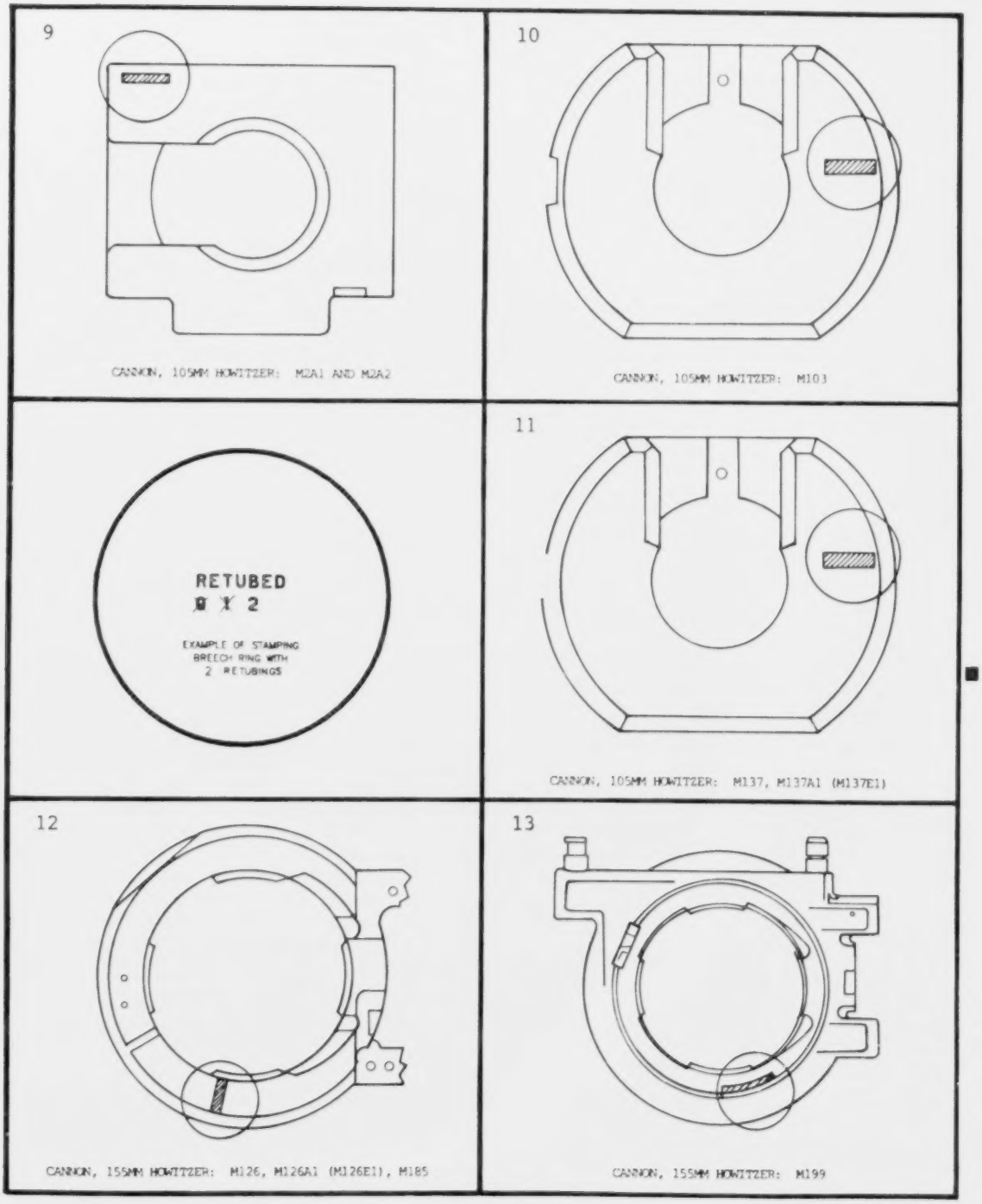


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Figure 3-2. Location of identifying number of retubings (3 of 3).

(2) To mark number of retubings:

(a) When tube in breech ring is original tube, stamp an "O" in appropriate space on breech ring, using the 1/8-inch die set.

(b) When a replacement tube is installed in a breech ring, the prior number should be cancelled with an "X" stamp and the next higher number applied.

EXAMPLE: If the stamping reads "1", this indicates that this breech ring has been retubed one time. If it reads "2", it has been retubed twice. Continue until maximum number of retubings, as specified in the applicable weapon table, has been reached.

(c) For marking of retubings only, ignore fact that replacement tube may not be new.

WARNING

During retubing, heed warning in weapon manual about making a careful check of tube breech ring assembly.

(d) Enter retubing information in record folder.

(e) In cases where word "RETUBED" was not stamped on breech ring during manufacture, stamp it in appropriate space.

(f) If you mistrust both figures in log book and on ring, do not use them. Send serial numbers, known history, bore measurements, borescope inspection information, and photos of bore and any damage to Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000 for a decision.

b. 105-MM M68/M68A1 Gun Breech Mechanism Assembly Replacement and Marking.

(1) This breech mechanism assembly is to be replaced after 5000 EFC rounds. Breech rings manufactured after 1977 will have the notation "EFC ROUNDS FIRED (K)" in the location shown in Figure 3-2. Numbers are to be stamped below this line to indicate increments of 1000 EFC rounds fired (0,1,2,...).

(2) The "RETUBED" marking on breech rings manufactured prior to 1978 is to be obliterated and "EFC ROUNDS FIRED (K)" metal stamped immediately above the obliterated marking. Each retubing previously marked on the breech ring is to be considered as representing 1000 EFC rounds fired. Subsequent stampings are to be applied following each 1000 EFC rounds fired.

c. 120-MM M256 Cannon

(1) This breech mechanism is to be replaced after 4500 EFC rounds. Breech rings manufactured prior to 1989 are stamped "RETUBED 0 1 2" on the upper left corner of the right hand side of the breech ring. This existing marking on these breech rings should be obliterated. Below the obliterated marking, stamp "EFC ROUNDS FIRED (K)" using 1/4 in. high metal stamp lettering and numbers having round faced character dies. Each retubing which has been previously marked on the breech ring is to be considered as representing 500 EFC rounds fired".

d. Other Parts Attached to Tube.

(1) When the breech ring with its final tube is condemned, all parts of the breech mechanism assembly are to be condemned. To follow this policy it is important that the components of each breech

mechanism assembly be kept together during maintenance and inspection and not interchanged with others of the same model. The only exceptions are obturator spindles, where used and breech operating lever assemblies. Both shall be inspected for possible reuse.

(2) 152-MM Gun Launchers: When "coupling" with its final tube and chamber are condemned (table 2-5), refer to technical manual of your weapon for allowable life of attached breech mechanism parts.

NOTE

When breech ring or "coupling" is not condemned, all attached parts should be inspected according to the DS/GS TM for your weapon.

(3) Send copies of records along with pullover gage readings, serial numbers of tube, breech ring, and weapon re-tubing markings, plus any known history to: Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000.

e. Visual Inspection. Includes use of following equipment.

(1) Borescope. Use it to find damages in bore and chamber. It is a telescope with a lighted mirror to give a close-up view. See TM 9-6650-235-13&P for instructions on how to select and use it.

NOTE

End views alone of bore are not clear enough to make proper decisions on how critical damage or wear is. Look at mirror of borescope to get a direct view down on tube wall. Do this along entire length of tube, including chamber. View a suspected defect at different angles by moving borescope slightly.

(2) Pullover Gage. Determine wear of a rifled tube bore by using a pullover gage which measures diameter across lands or a smooth bore at the axial location stated in paragraph 3-8 pertaining to the specific weapon. See TM 9-4933-258-13&P for instructions on how to select and use it.

(3) Special Equipment. See paragraph 3-8 pertaining to specific weapons. The 120-MM M256 Cannon tube requires inspection with a borescope and the Bore Erosion Gage (P/N 12520840) which attaches to the borescope and provides a direct visual reading of the depth of erosion in the base metal of the tube bore.

f. Difficult Inspection. When damage is unique and difficult to analyze, take photographs of damage and ship them with pullover gage readings and DA Form 2408-4 Weapon Record Data Card to: Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000, for a decision. DO NOT fire weapon.

3-8. Inspection of Tubes Condemnable on the Basis of Erosion

a. 40-MM Gun Cannon, M2A1.

Borescope and pullover gage after every 2,000 rounds until 10,000 is reached, then after every 1,000 rounds. Refer to table 3-2.

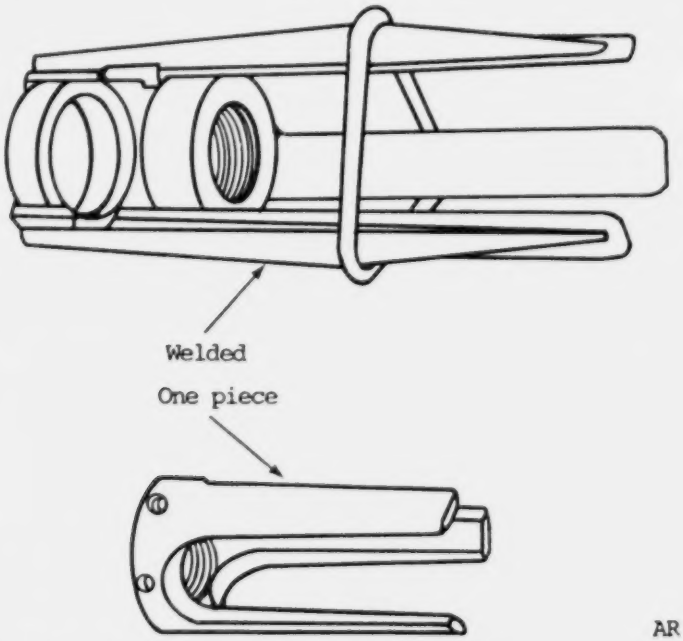

Figure 3-3. Flash suppressors: 40-MM gun cannon, M2A1.

Table 3-2. Estimated Remaining Life of Cannon Tube of 40-MM Gun Cannon, M2A1 For: Gun, SP, FT, Twin, M42 and M42A1

Bore measurement 13.75-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.000	1.573	100	12,000
0.002	1.575	95	11,400
0.003	1.576	90	10,800
0.004	1.577	85	10,200
0.006	1.579	80	9,600
0.008	1.581	75	9,000
0.010	1.583	70	8,400
0.013	1.586	65	7,800
0.015	1.588	60	7,200
0.018	1.591	55	6,600
0.021	1.594	50	6,000
0.024	1.597	45	5,400
0.027	1.600	40	4,800
0.030	1.603	35	4,200
0.033	1.606	30	3,600
0.036	1.609	25	3,000
0.039	1.612	20	2,400
0.042	1.615	15	1,800

Table 3-2. Estimated Remaining Life of Cannon Tube of 40-MM Gun Cannon, M2A1 For: Gun, SP, FT, Twin, M42 and M42A1--Continued

Bore measurement 13.75-inches forward of breech face		Estimated remaining life	
0.045	1.618	10	1,200
0.049	1.622	05	600
*0.052	*1.625	00	000

*Condemnation Limit: Condemnation is based on tube wear and not on rounds fired.

All rounds have an EFC number of 1.0

Life can vary from 4,000 to 16,000 rounds (depending on the amount of overheating due to continuous firing).

Retubings are unlimited.

Flash suppressor shall be condemned at 4,000 rounds for the one piece type, or 1,500 rounds for the welded type (fig 3-3).

The 40-MM flash suppressors are serial-numbered with numbers stamped in the metal at the back of each suppressor. A DA Form 2408-4 should be compiled for every 40-MM flash suppressor for retaining a rounds count record. The flash suppressor serial number should be entered in block 1 of the 2408-4. In block 1, cross out the word "TUBE" and write in the words "FLASH SUPPRESSOR."

b. 90-MM Cannon, M41 (Table 3-3).

(1) Borescope every 500 rounds, regardless of EFC.

(2) Inspect exterior every 1,000 rounds, regardless of EFC. Also, pullover gage after 1,000 M431A2 rounds have been fired and after every additional 500 of these rounds.

(3) Borescope and pullover gage at 200 round intervals after firing 2,000 rounds, regardless of EFC.

(4) When gaging, also measure for muzzle wear at two inches from end. Condemn tube when land diameter there reaches 3.563-inches. Wear (erosion) could be eccentric, so measure in a number of directions.

(5) Condemn tubes reaching 3,000 rounds, regardless of EFC or at 0.197-inches wear, whichever comes first.

Table 3-3. Estimated Remaining Life of Tube of 90-MM Gun Cannon, M41 For: Tanks, M48 Series

Bore measurement 25.25-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.000	3.543	100	700
0.001	3.544	95	665
0.006	3.549	90	630
0.015	3.558	85	595
0.029	3.572	80	560
0.055	3.598	75	525
0.072	3.615	70	490
0.086	3.629	65	455
0.100	3.643	60	420
0.110	3.653	55	385
0.120	3.663	50	350
0.129	3.672	45	315
0.137	3.680	40	280
0.145	3.688	35	245
0.153	3.696	30	210
0.161	3.704	25	175
0.169	3.712	20	140
0.176	3.719	15	105
0.183	3.726	10	70
0.190	3.733	05	35
*0.197	*3.740	00	00

*Condemnation Limit: Condemnation based on tube wear.

Table 3-3. Estimated Remaining Life of Tube of 90-MM Gun Cannon, M41 For: Tanks, M48 Series--Continued
EFC Factors Based on Use With Specific Ammunition

Round Type	M-model	EFC
CSTR	XM590	
AP-T	M318	0.61
AP-T	M318A1	1.00
APC-T	M82	0.61
APERS-T	XM580E1	1.00
CSTR	M336	0.71
CSTR	M377	0.42
HE	M71	0.42
HE-T	M71A1 (M71E1)	0.19
HEAT-T	*M431A2	**

*When firing this cartridge in a new tube, 1,000 rounds may be fired before the chrome is broken through. Since the wear to this point is negligible, an EFC factor should not be used with this round.

**Discontinue use of HEAT-T (M431A2) at 0.120-inches wear (3.663" diameter) due to loss of accuracy. Switch to other rounds.

SMK-WP	M313C	0.42
TP-T	***M353A1	1.00

***Loses accuracy at 500 rounds.

Retubings allowed: 7

c. 105-MM Gun Cannon, M68 (T254E1).

(1) The 105-MM M68 Gun Tube is condemned under dual criteria, based on tube wear or EFC round count.

(2) Pullover gage and borescope inspect the gun tube as specified in paragraph 3-3. Additionally, the interval between pullover gage measurement and borescope inspection is not to exceed 200 EFC rounds. Information carried forward to each new DA Form 2408-4 is to include the EFC rounds remaining at the last pullover gage measurement and borescope inspection.

(3) In addition to the general visual inspection criteria of paragraph 3-9, visual evidence of a complete interruption of any rifling land is cause for condemnation of this gun tube.

(4) WP and HEP-type ammunitions (M416, M467, and M393 series) have EFC factors of 0.5. All other ammunition has an EFC factor of 1.0. These EFC factors apply to ammunition fired at ambient temperatures of 105°F (40.6°C) or below. When fired at ambient temperatures above 105°F (40.6°C), the EFC factor is doubled for each round.

(5) Condemn the gun tube when 1000 EFC rounds have been fired or at 0.056 inch wear with measurement taken at 25.25 inches forward of breech end of cannon tube with original diameter of 4.134 inches, whichever occurs first.

(6) Condemn the 105-MM M68 Gun Breech Mechanism Assembly after 5000 EFC rounds have been fired (para 3-7*a.1*).

Table 3-4 deleted.

d. 120-MM Gun, Cannon M256

(1) The 120-MM M256 Tube is condemned under dual criteria based on tube bore erosion depth or EFC round count, whichever occurs first.

(2) Inspection of the tube bore using the borescope and the attaching Bore Erosion Gage (P/N 12520840) shall be performed at intervals specified in Para 3-3. As the EFC round count increases, the loss of chrome plating in the tube bore will occur. Chrome loss will be evident in varying sizes, shapes, and degree in the form of chipping, pitting, areas of stripped chrome. In these areas of chrome loss, erosion into the surface of the base metal in the tube will eventually occur with increasing round count. Examples of each of the above conditions are illustrated in the photographs of Figure 3-67 through Figure 3-70.6 starting on page 3-119. The above information and EFC life remaining is to be carried forward to each new DA Form 2408-4.

NOTE:

The loss of small amounts of chrome plate over the life of the gun tube will not affect accuracy or safety of the gun tube.

(3) The tube is to be condemned when 750 EFC rounds have been fired, or when the erosion depth measured at any one point in the bore reaches 5-MM depth, whichever occurs first.

(4) Condemn the 120-MM M256 Breech Mechanism when 4500 EFC rounds have been fired.

e. *120-MM Gun Cannon, M58 (T123E1) (Tube is chrome-plated) (Table 3-5).* Borescope, pullover gage and inspect exterior keyways and threads after every 100 EFC rounds.

Table 3-5. Estimated Remaining Life of Cannon Tube of 120-MM Gun Cannon, M58 (T123E1) For: Tank, Combat, FT, M103A2
Estimated Tube Life Based on Bore Measurement

Bore measurement 38.25-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.000	4.700	100	250
0.002	4.702	95	238
0.010	4.710	90	225
0.062	4.762	85	213
0.090	4.790	80	200
0.109	4.809	75	188
0.124	4.824	70	175
0.138	4.838	65	163
0.149	4.849	60	150
0.160	4.860	55	138
0.170	4.870	50	125
0.179	4.879	45	113
0.188	4.888	40	100
0.197	4.897	35	88
0.205	4.905	30	75
0.213	4.913	25	63

Table 3-5. Estimated Remaining Life of Cannon Tube of 120-MM Gun Cannon, M58 (T123E1) For: Tank, Combat, FT, M103A2
Estimated Tube Life Based on Bore Measurement--Continued

Bore measurement 38.25-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.221	4.921	20	50
0.228	4.928	15	38
0.236	4.936	10	25
0.243	4.943	05	13
*0.250	*4.950	00	00

*Condemnation Limit: Condemnation will be based on tube wear and not on rounds fired.

Table 3-5. Estimated Remaining Life of Cannon Tube of 120-MM Gun Cannon, M58 (T123E1) For: Tank, Combat, FT, M103A2--Continued
EFC Factors Based on Use With Specific Ammunition

Round			
Type	M-model	T-model	EFC
AP-T	M358		1.00
TP-T	M359	T147E7	1.00
TP-T	M359E2		1.00
HEAT-T	M469	T153 Series	0.75
HE-T	M356	T15E3	0.094
SMK, WP-T	M357	T16E4	0.094

Retubings allowed: 4

f. *155-MM Gun Cannon, M46 (Chamber only is chrome-plated)* (Table 3-6). rounds, borescope and pullover gage after every 100 EFC rounds. After 500 EFC

Table 3-6. Estimated Remaining Life of Cannon Tube of 155-MM Gun Cannon, M46 For: Gun, SP, FT, M53 (T97)
Estimated Tube Life Based on Bore Measurement

Bore measurement 47.75-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.000	6.100	100	700
0.007	6.107	95	665
0.014	6.114	90	630
0.021	6.121	85	595

Table 3-6. Estimated Remaining Life of Cannon Tube of 155-MM Gun Cannon, M46 For: Gun, SP, FT, M53 (T97) Estimated Tube Life Based on Bore Measurement--Continued

Bore measurement 47.75-inches forward of breech end of cannon tube		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.028	6.128	80	560
0.035	6.135	75	525
0.042	6.142	70	490
0.049	6.149	65	455
0.056	6.156	60	420
0.062	6.162	55	385
0.068	6.168	50	350
0.074	6.174	45	315
0.079	6.179	40	280
0.084	6.184	35	245
0.089	6.189	30	210
0.093	6.193	25	175
0.097	6.197	20	140
0.100	6.200	15	105
0.103	6.203	10	70
0.107	6.207	05	35
*0.110	*6.210	00	00

*Condemnation Limit: Condemnation will be based on tube wear and not on rounds fired.

Table 3-6. Estimated Remaining Life of Cannon Tube of 155-MM Gun Cannon, M46 For: Gun, SP, FT, M53 (T97)--Continued
EFC Factors Based on Use With Specific Ammunition

Round				
Type	M-model	Charge	Zone	EFC
HE	M101	M-19	Super	1.00
ILLUM	M118 Series		Normal	0.24
SMK, WP	M104			
Gas, Pers, HD	M104			
Gas, Non-Pers, G	M122			

The above rounds may be used interchangeably with above 2 zones

Retubings allowed: 4

g. 155-MM Howitzer Cannon, M185

(1) Borescope after every 1,000 EFC rounds.

(2) Beginning at 4,000 EFC rounds, borescope and pullover gage at 500 EFC round intervals.

(3) Condemn tube when pullover gage shows 0.150-inch wear (actual diameter 6.250-inches) at 40.00 inches forward of breech face.

(4) Condemn tube at 6,375 EFC rounds. EFC factors are: Zone 8 = 1.00, Zone 7 = 0.75, Zone 1-6 = 0.25.

(5) Retubings allowed: 2.

h. 165-MM Gun Cannon, M135, on Combat Engineer Vehicle M728.

(1) Borescope after every 250 rounds. Pullover gage after every 1,000 rounds. (Each round has an EFC value of one.)

(2) Condemn tube when pullover gage shows 0.100-inch wear (new finish bore size is 6.500, actual diameter 6.600-inches) at 89.75-inches from muzzle end. However, wear is very slow and there is no table of estimated remaining life.

(3) Retube breech ring if tube is damaged. There is no limit to the number of retubings.

i. Deleted.

j. 8-Inch Howitzer Cannon, M201/M201A1.

(1) Borescope and pullover gage every 1,000 EFC rounds.

(2) Condemn tube for wear or for EFC rounds fired (table 3-7).

(3) Deleted.

(4) Note that the breech mechanism can be rebushed only at Watervliet Arsenal.

(5) Use figure 3-4 for identifying and stamping the number of rebushings.

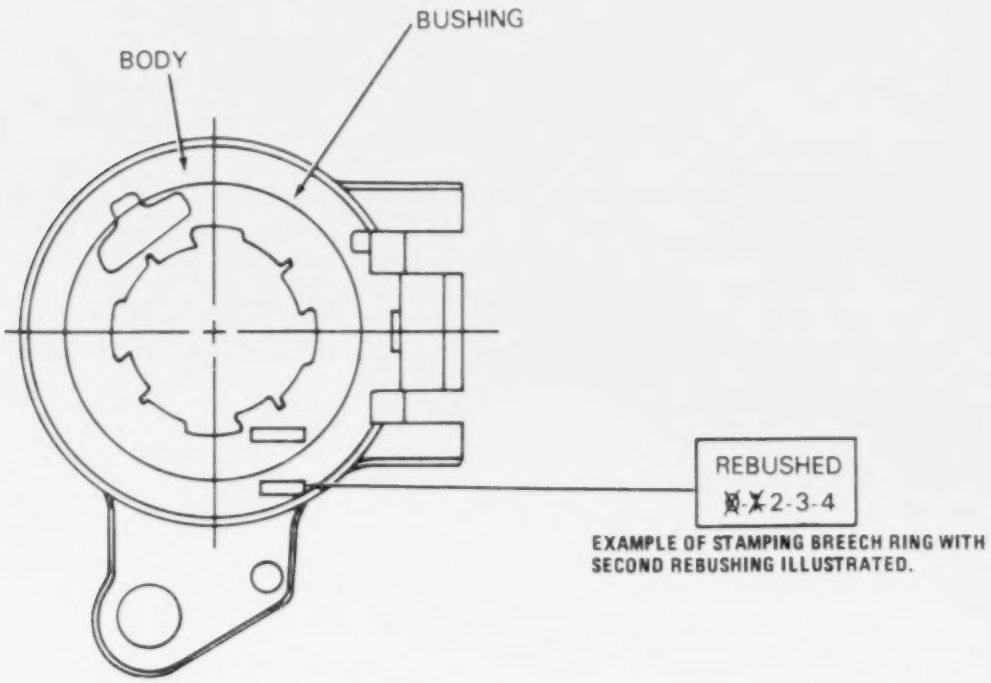

Figure 3-4. Identifying number of rebushings, 8-inch howitzer cannon, M201/M201A1.

Table 3-7. Life of 8-Inch Howitzer Cannon, M201/M201A1 For Self-Propelled Howitzer, M110A1/M110A2

Service life of tube	EFC factors	Breech life	Remarks
10,000 EFC rounds or 0.135-inch wear	Zone 9 = 1.00 Zone 7-8 = 0.75 Zone 1-6 = 0.25	See note 2	See note 1 See note 4

Note 1: Condemnation criteria for the tube is based on a pullover gage measurement of 8.135 inches measured 46-inches forward of the rear face of the tube or a 10,000 EFC round count, whichever occurs first.

Note 2: Breech may be rebushed four times (para 3-8j (4)).

Note 3: Deleted.

Note 4: Location and method of stamping for rebushings is shown on figure 3-4.

3-9. Visual Inspection and Criteria for Various Types of Damage

a. General.

NOTE

Clean the tube all over very carefully.

(1) View tube's exterior for cracks and gouges. All holes and keyways should be examined very carefully.

(2) Borescope entire bore for damage to tube caused by ammunition, dirt, structural defects, hostile fire, abuse by gunners, etc. Pay special attention to origin of rifling area (breech end).

NOTE

See TM 9-4933-200-35 for complete information regarding borescopes and pullover gages. See TM 9-2350-264-34-2-2 regarding the Bore Erosion Gage used for inspection of 120-MM M256 tubes.

(3) Use illustrations with following descriptions to aid in making decisions regarding use of tubes.

b. Cracks.

(1) Cracks may grow progressively worse through continued firing. Therefore a cannon tube may be condemnable even though condemnation limit for wear or fatigue life has not been reached; however, take care not to overstate a defect. After much firing, some heat checks become real cracks (fig 3-5 through 3-8, 3-13, 3-14, 3-17, and 3-53 through 3-56).

(2) Not all defects that appear to be cracks are true cracks; therefore, it is necessary to evaluate each defect. Cracks must be differentiated from other defects such as scratches, heat checks, stripped lands, and superficial metallic flaws. Typical characteristics of a crack may include feathered edges running in an irregular line, varying width and depth. Tool marks and scratches usually run in a straight line, or have smooth edges, uniform width, or shallow depth, but sometimes they deepen into cracks. Cracks may be found diagonally or transversely across or parallel to the lands and grooves (fig 3-5 through 3-17, 3-23 through 3-26, and 3-53 through 3-56).

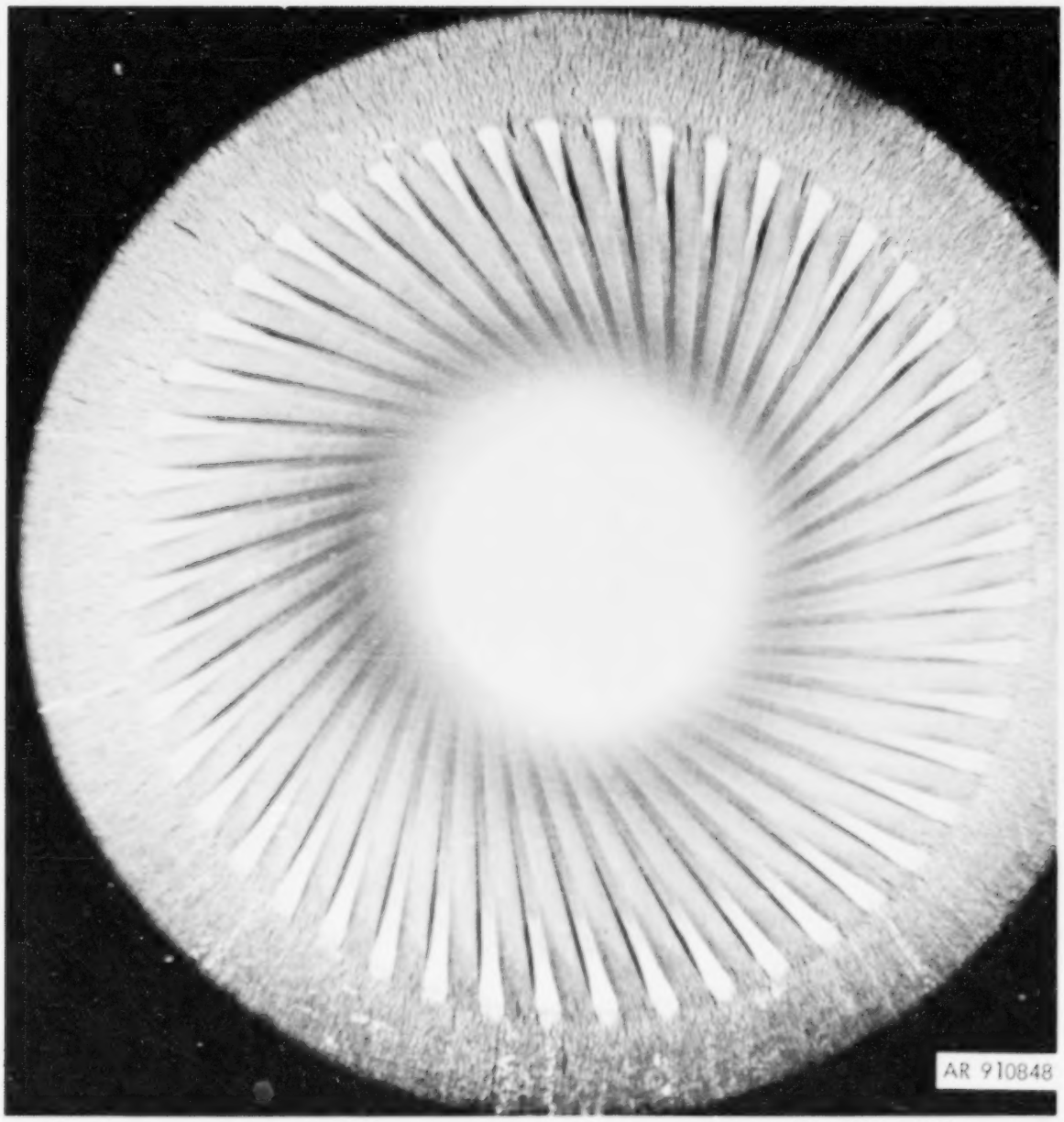

Figure 3-5. Progressive cracking: end view of origin of rifling: 155-MM howitzer cannon, M1A1, after 7,000 rounds: ACCEPTABLE.

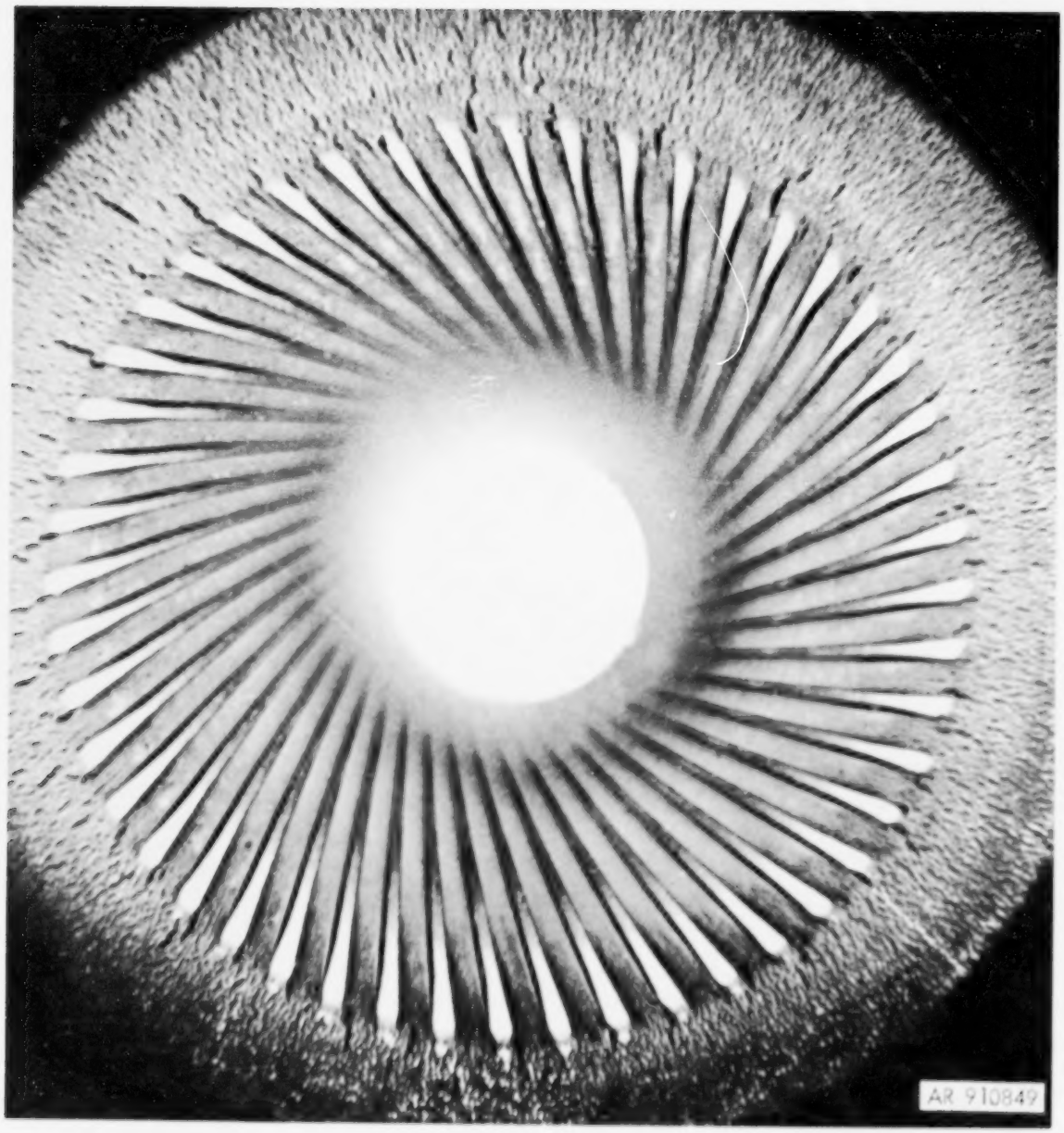

Figure 3-6. Progressive cracking after 9,000 rounds: ACCEPTABLE.

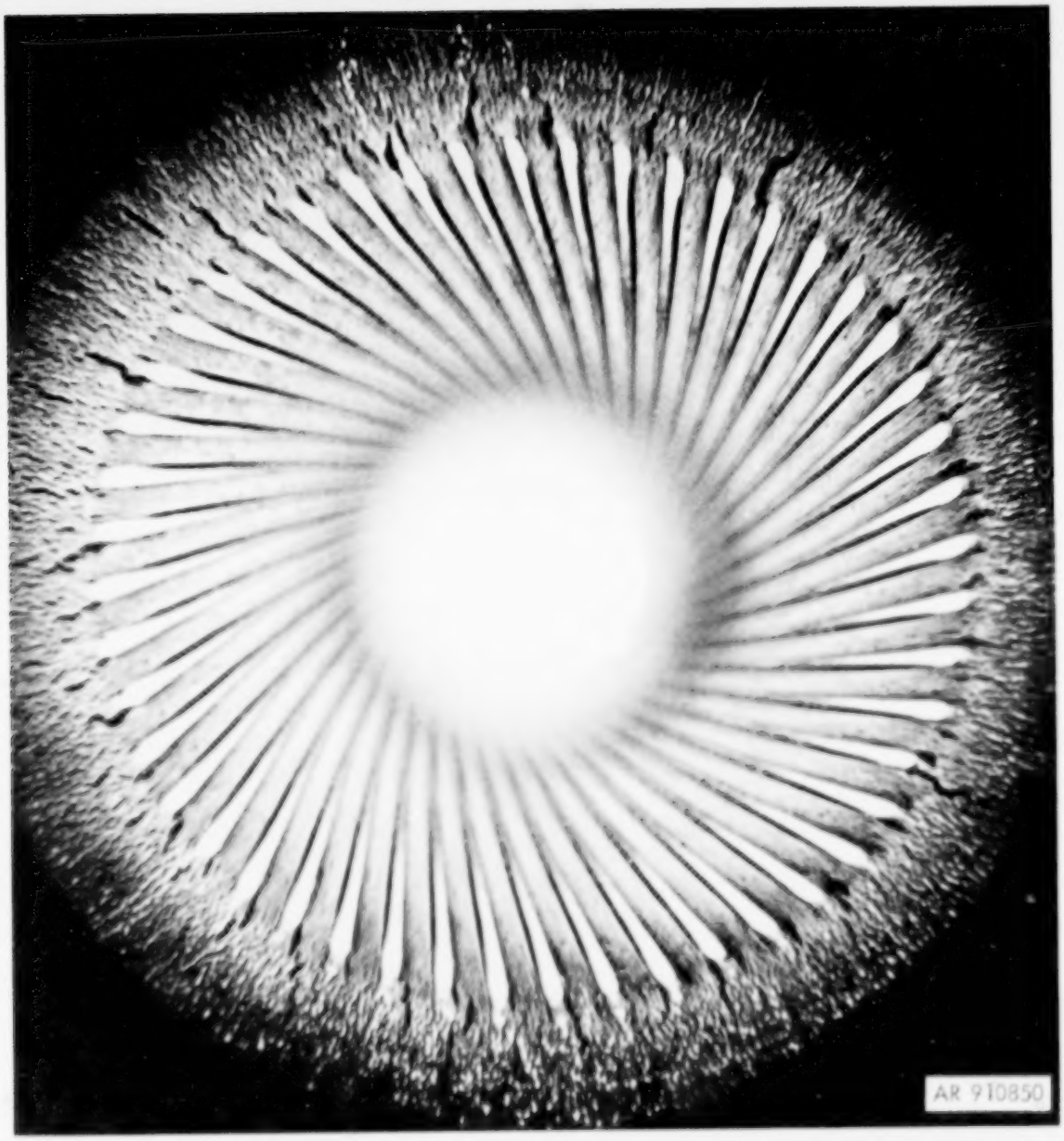

Figure 3-7. Progressive cracking after 12,000 rounds. View not clear enough. Use borescope mirror.

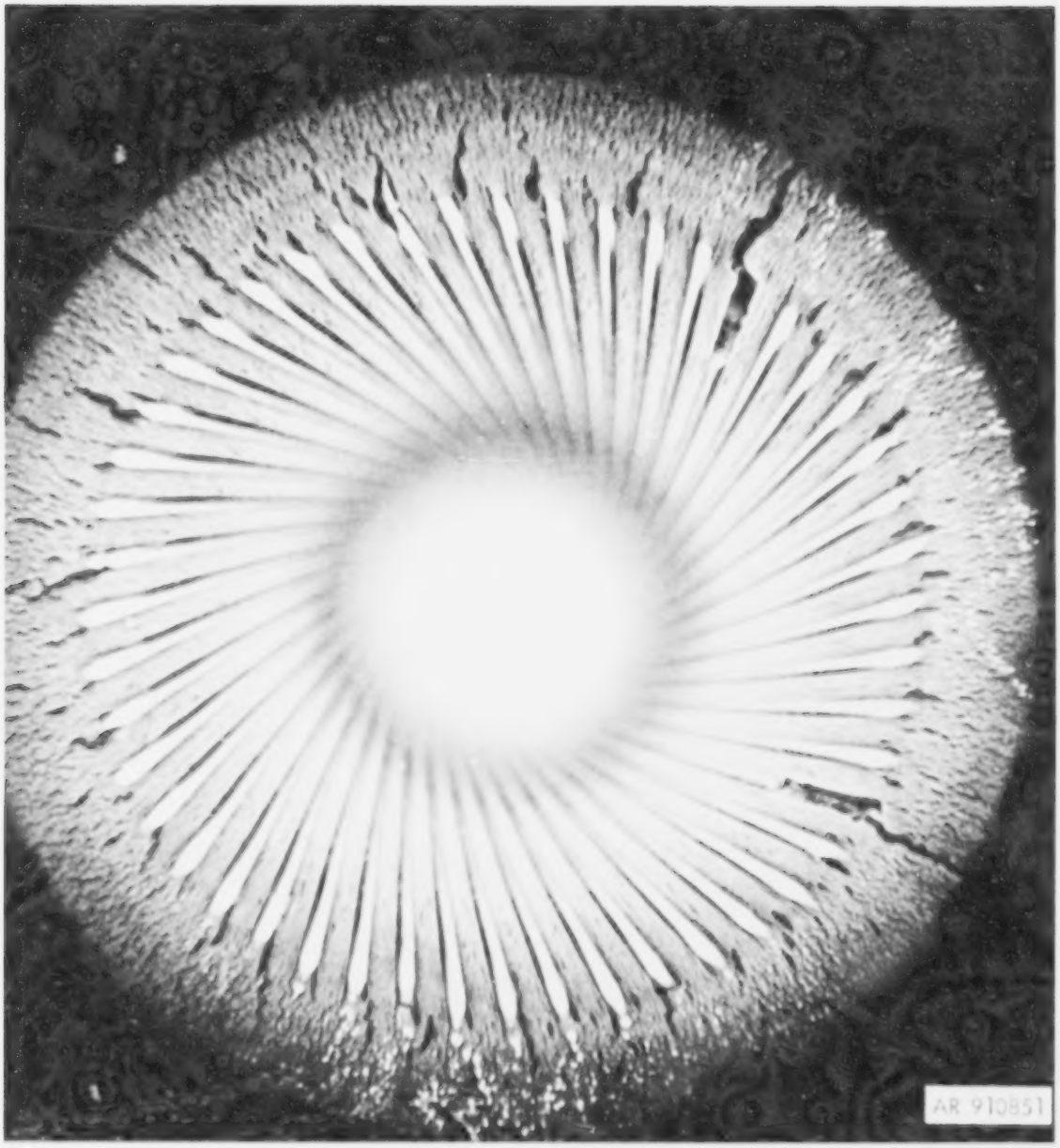

Figure 3-8. Progressive cracking after 15,000 rounds. Apparent cracks but use borescope mirror.

Figure 3-9. Deleted.

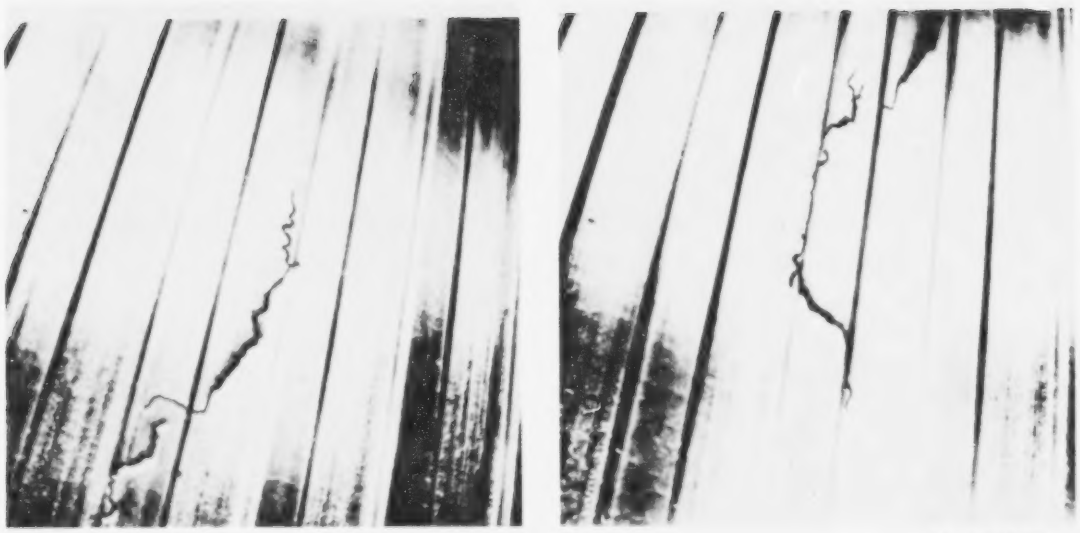

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Figure 3-10. Cracks across lands and grooves: CONDEMN.

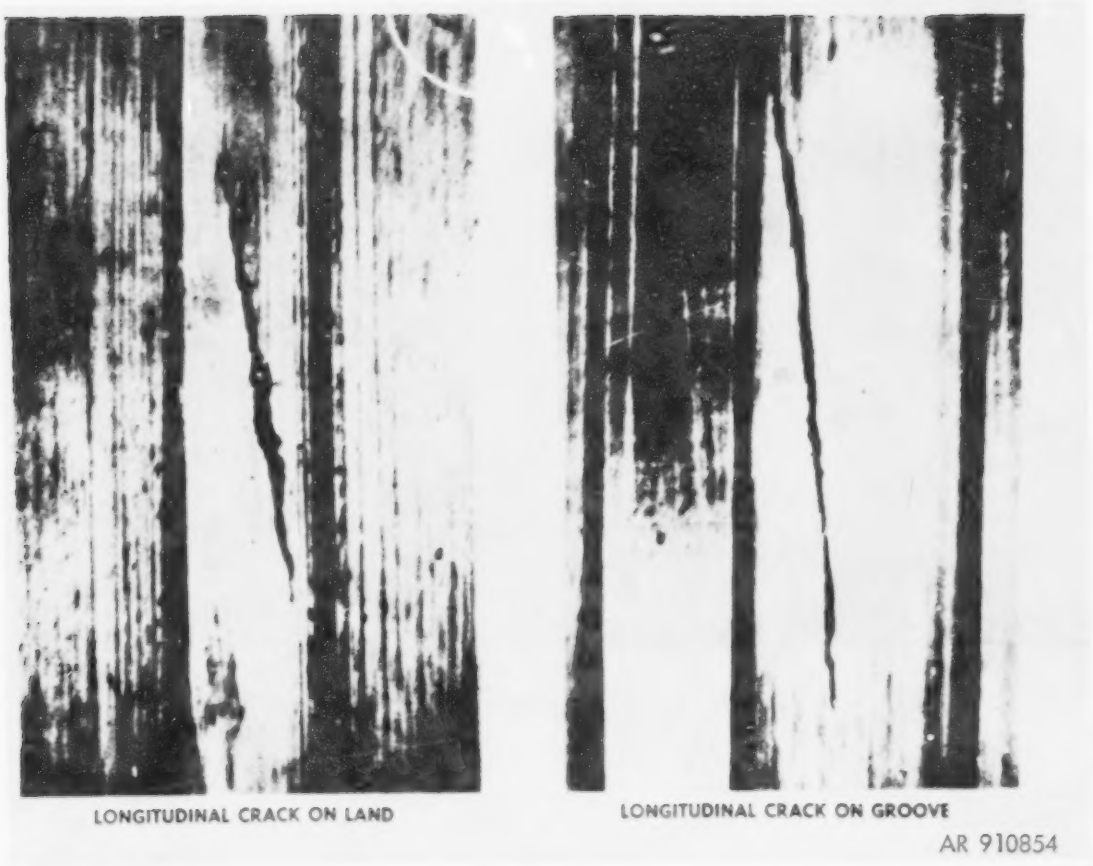


Figure 3-11. Longitudinal crack on land or groove.

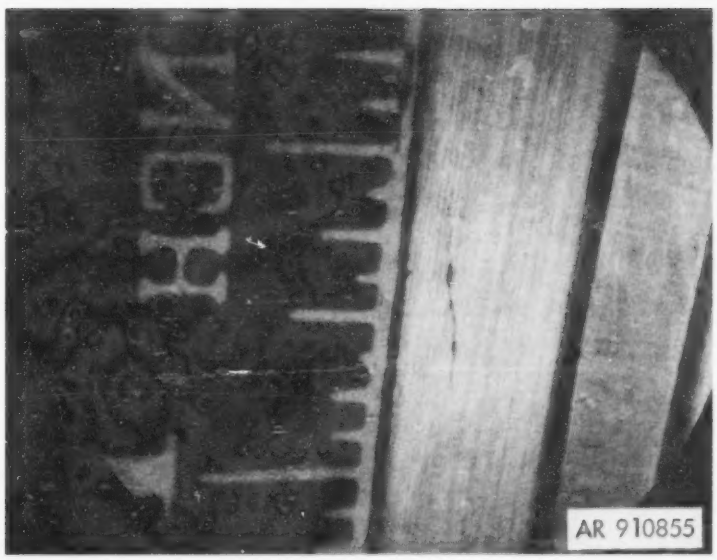


Figure 3-12. Crack in groove: 105-MM gun cannon, M68.

Figure 3-13. Deleted.

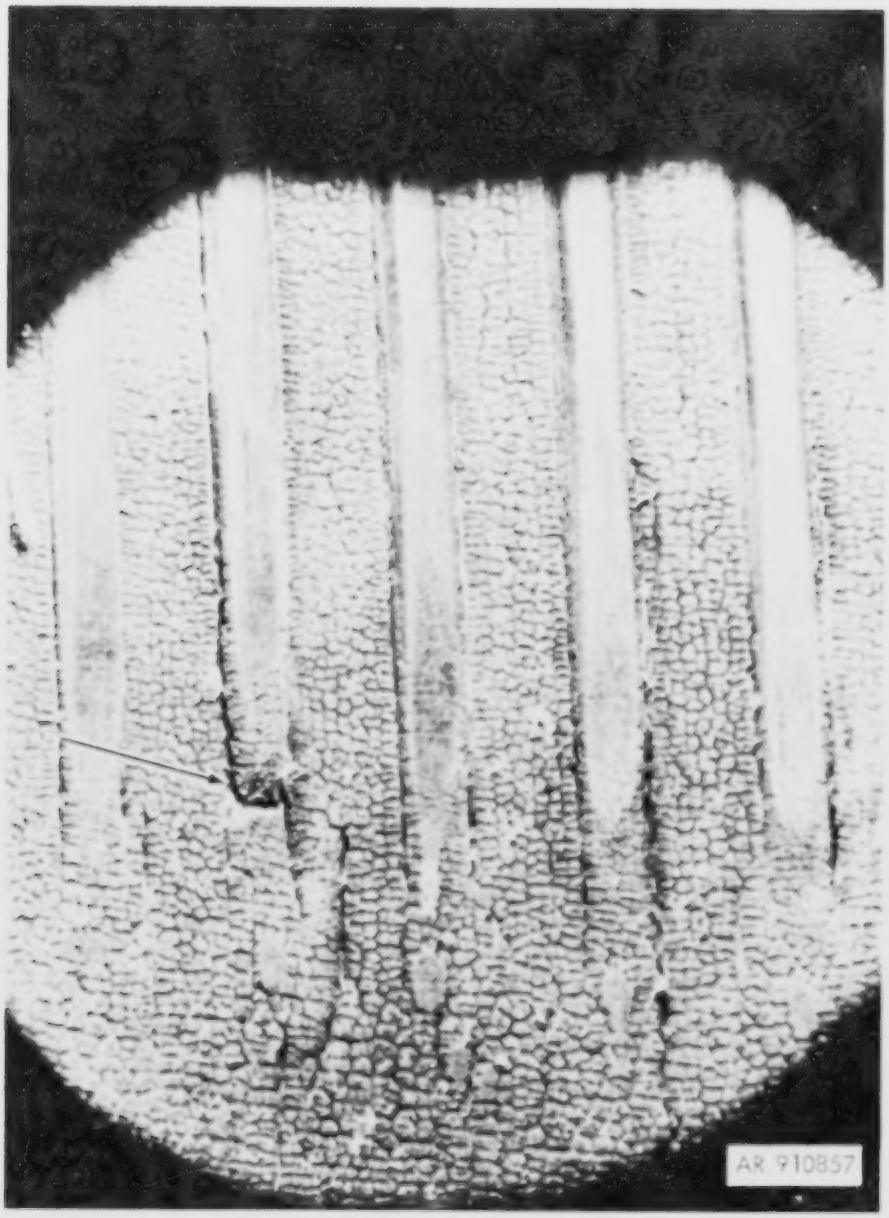


Figure 3-14. Single crack and two incipient cracks at origin of rifling.

(3) Cracks may also be found in the chamber portion of the cannon (fig 3-15, 3-16, and 3-17). Examples of cannon tubes with cracks at evacuator holes are shown in paragraph 3-9*c*.

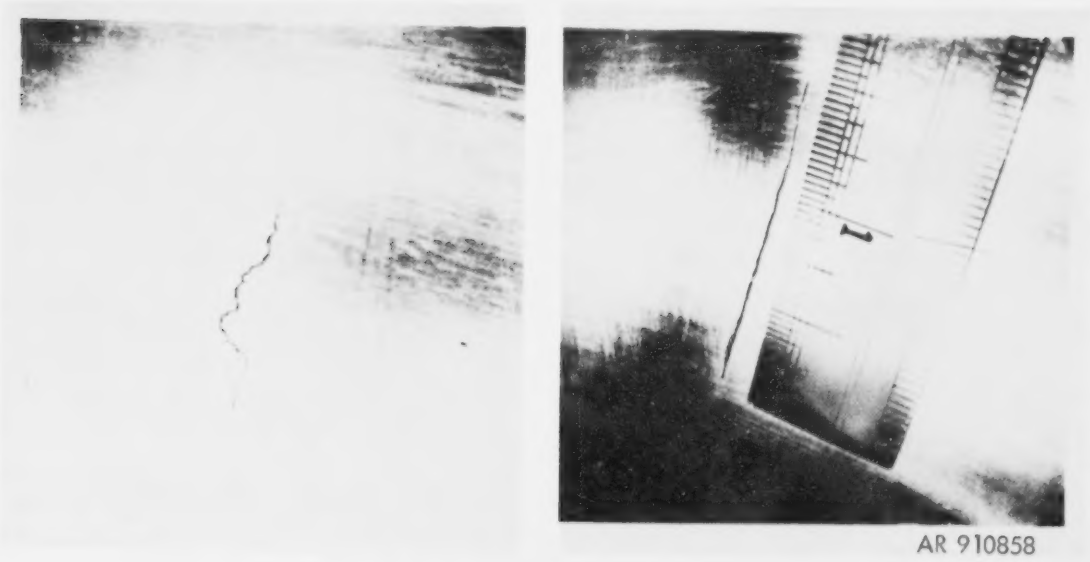


Figure 3-15. Cracks in chamber.

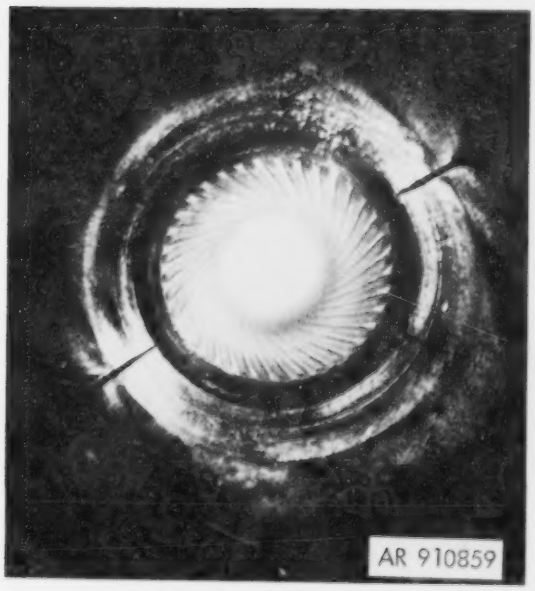


Figure 3-16. Split chamber caused by split case: CONDEMN. 105-MM howitzer cannon, M2A2,

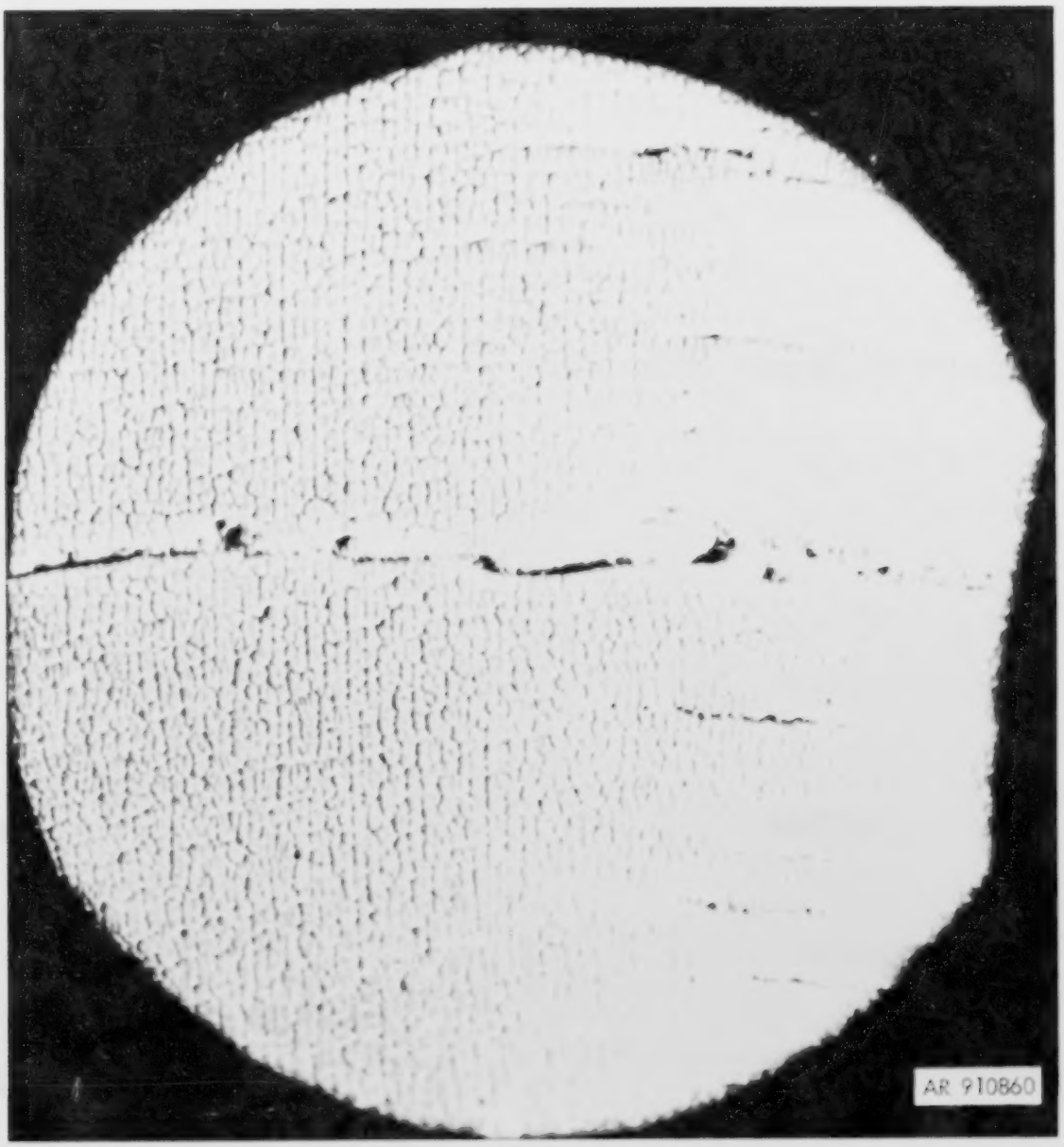
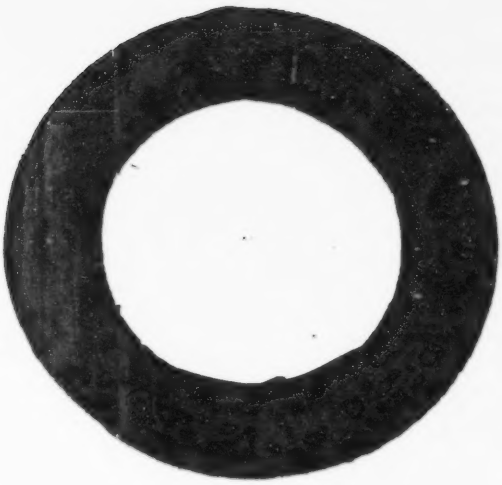


Figure 3-17. View of crack due to fatigue after 15,000 rounds extending from forward of origin of rifling rearward into chamber: CONDEMN 155-mm howitzer cannon, M1A1. (1 of 2)



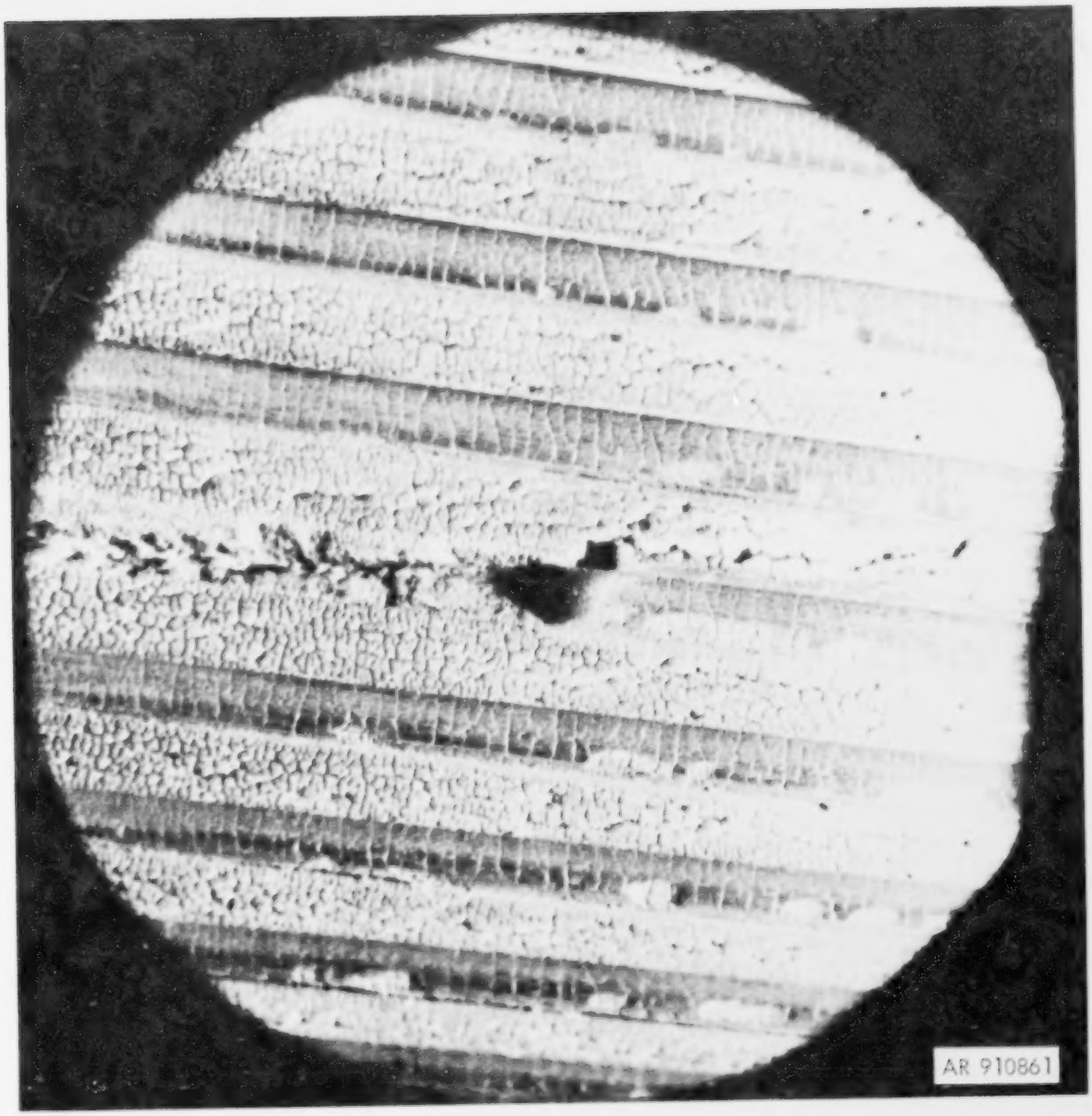
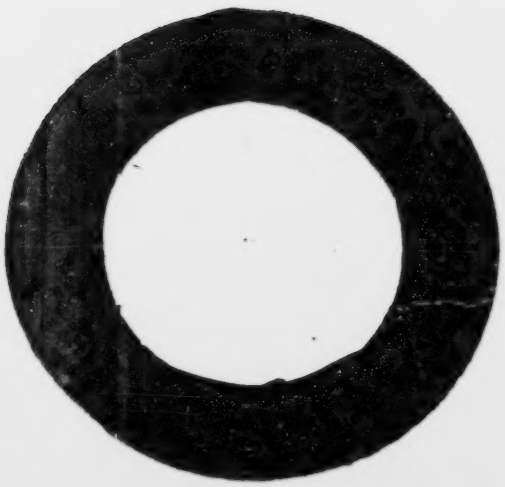


Figure 3-17. View of crack due to fatigue after 15,000 rounds extending from forward of origin of rifling rearward into chamber: CONDEMN. 155-mm howitzer cannon, M1A1. (2 of 2)



(4) The condition of rifling lands may affect accuracy (fig 3-18). This is especially true in high velocity cannon where it can result in stripping or shearing of the ammo's rotating band. The characteristics of deformation of lands in cannon tubes are covered in *(a)* through *(e)*:

(a) In some tubes, lands become hammered, or battered, allowing propellant gas to leak past projectile.

(b) Edges of lands often chip or spall.

(c) When a crack spreads upward from a corner, a part of the land is sheared (fig 3-19).

(d) When a crack spreads fully across or underneath a land, the land is said to be sheared (fig 3-19). When one or both ends of the sheared land remain attached to bore interface, land is *raised* (fig 3-20). If raised portion is near origin of rifling, it could prevent the loading or seating of a projectile. When ends break off and land is missing, land is said to be stripped.

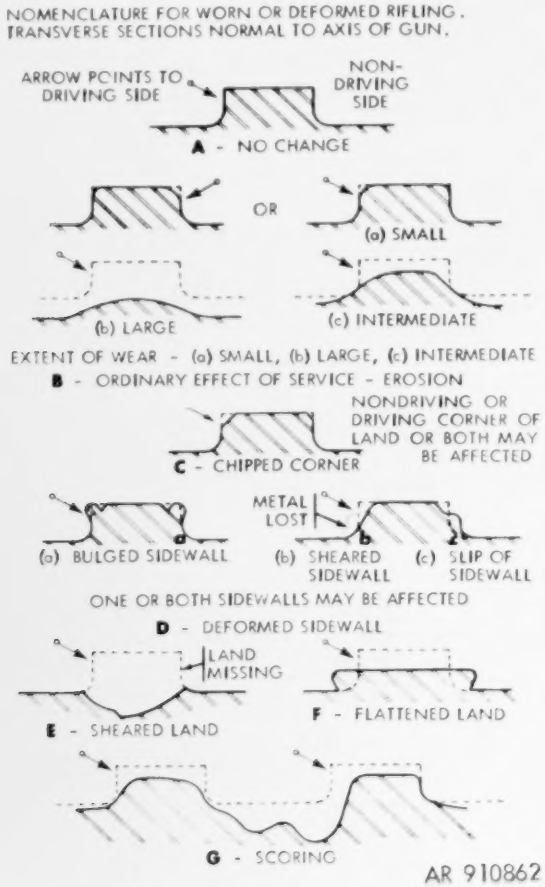

NOMENCLATURE FOR WORN OR DEFORMED RIFLING.
TRANSVERSE SECTIONS NORMAL TO AXIS OF GUN.
ARROW POINTS TO DRIVING SIDE
NON-DRIVING SIDE
A - NO CHANGE
OR
(a) SMALL
(b) LARGE
(c) INTERMEDIATE
EXTENT OF WEAR - (a) SMALL, (b) LARGE, (c) INTERMEDIATE
B - ORDINARY EFFECT OF SERVICE - EROSION
NONDRIVING OR DRIVING CORNER OF LAND OR BOTH MAY BE AFFECTED
C - CHIPPED CORNER
METAL LOST
(a) BULGED SIDEWALL
(b) SHEARED SIDEWALL
(c) SLIP OF SIDEWALL
ONE OR BOTH SIDEWALLS MAY BE AFFECTED
D - DEFORMED SIDEWALL
LAND MISSING
E - SHEARED LAND
F - FLATTENED LAND
G - SCORING
AR 910862

Figure 3-18. Nomenclature for conditions of rifling lands.

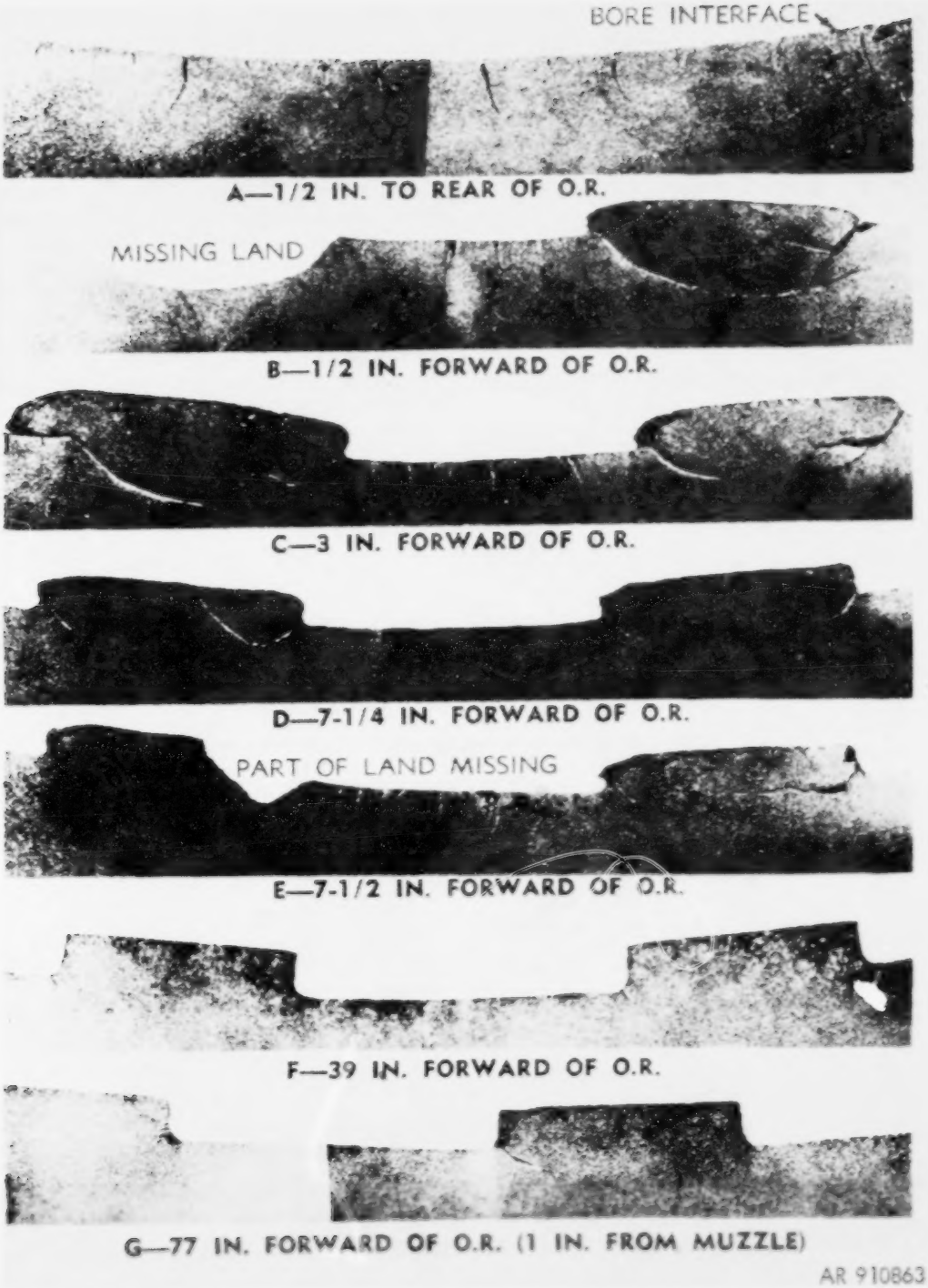

BORE INTERFACE
A—1/2 IN. TO REAR OF O.R.
MISSING LAND
B—1/2 IN. FORWARD OF O.R.
C—3 IN. FORWARD OF O.R.
D—7-1/4 IN. FORWARD OF O.R.
PART OF LAND MISSING
E—7-1/2 IN. FORWARD OF O.R.
F—39 IN. FORWARD OF O.R.
G—77 IN. FORWARD OF O.R. (1 IN. FROM MUZZLE)
AR 910863

Figure 3-19. Traverse section showing shearing, stripping, and deformation of lands.

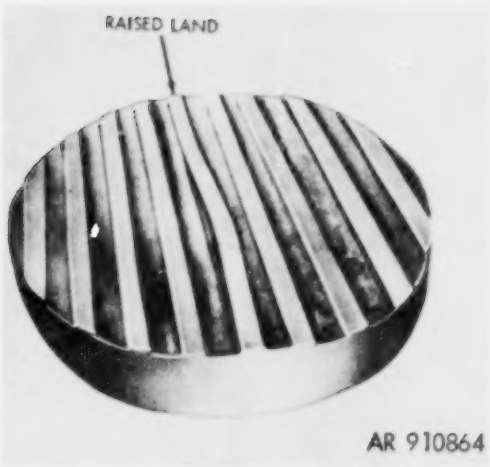


Figure 3-20. Raised land: NOT ACCEPTABLE. Send to depot for overhaul.

(e) Lands usually erode most at origin of rifling (fig 3-21, 3-22, and 3-28 through 3-36).

c. Criteria on Cracks

CAUTION

Take great care to make certain that it is a real crack. View each suspected crack or damaged area from a number of angles in order to assure that lighting and shadows are not misleading you.

(1) External Surfaces: Condemn tube when you find:

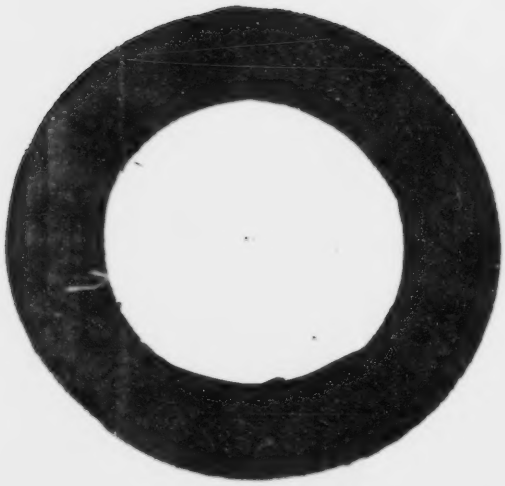
(a) Any crack (except cracks on threads for evacuators or muzzle brakes which do *not* reach tube surface or thread root).

(b) On 105-MM Gun, M68 tube of serial number 7500 or higher: cracks over 1/4-inch long in keyways, threads or evacuator holes; cracks over 3/8-inch long elsewhere.

(2) Internal Surfaces

(a) Condemn any *traverse* or *diagonal* crack in chamber (fig 3-15 and 3-16), or which extends from a land into a groove (fig 3-10 and 3-23).

Figure 3-21. Lands eroded at origin of rifling: ACCEPTABLE. 155-MM howitzer cannon, M1A1.



All data on page 3-53 including
figure 3-22 deleted

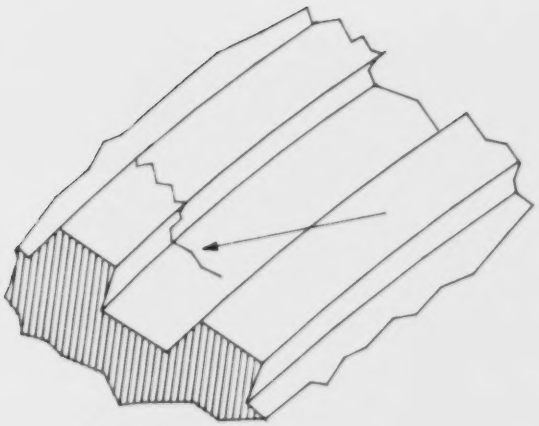


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Figure 3-23. Crack across thread extending into tube surface: CONDEMN

(b) Longitudinal (axial) crack or suspected crack in chamber or in adjacent 2 feet of rifling: Over 2-inches long, condemn. Between 1 and 2-inches long, measure length, record it, allow 100 EFC rounds to be fired, re-measure and condemn if crack has lengthened. Under 1-inch long, record it and be sure to inspect it next time (fig 3-9, 3-13 and 3-14).

(c) Longitudinal cracks or suspected cracks in lands or grooves over 2 feet away from origin of rifling: Condemn if over 1/2-inch long, except that on 105-MM Gun, M68 tubes of serial number 7500 and higher allow maximum of 1-1/4-inch (fig 3-11 and 3-12).

(d) Deleted.

(e) On 152-MM Gun Launchers: In addition to above, see paragraphs 3-10, 3-11, and 3-12.

(3) At evacuator holes: When borescope shows crack at hole, see if crack extends to tube exterior. If so, condemn (fig 3-24 and 3-25). If borescope shows crack extending from hole across adjacent land, condemn (fig 3-26).

Figure 3-24. Evacuator hole: Internal crack on feather edge: ACCEPTABLE. Possible external crack: INSPECT OUTSIDE.

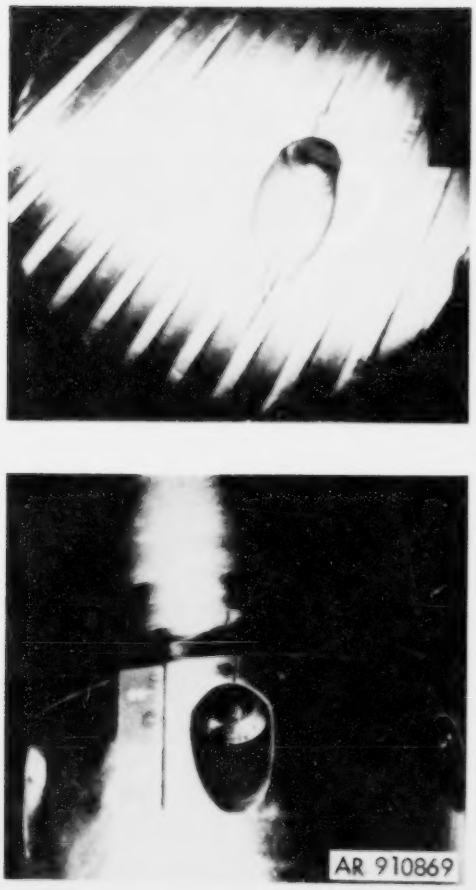


Figure 3-25. Evacuator hole: lower: external crack: CONDEMN, upper: internal crack on feather edge of hole: ACCEPTABLE. upper: internal crack on outer side of hole: CONDEMN.

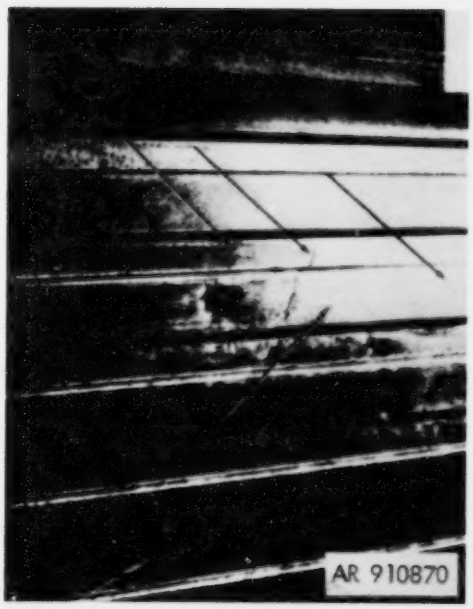


Figure 3-26. Four cracks at and near evacuator hole: CONDEMN. 105-MM gun cannon, M68/M68A1.

d. Deformation of Lands

(1) By erosion (wear): Erosion at origin of riflings wears down the lands and causes the actual origin to move forward. Usually not critical. Erosion may cause rounding of edges of lands. Usually not critical. Erosion in chrome plated tubes (such as in 90-MM Gun, M41) appears different from that in non-plated tubes. Examples of erosion are figures 3-27 through 3-36.

(2) 155-MM M185. Damage to lands, as shown in figure 3-27 and 3-27.1, is often found in the area up to (10) inches forward of the origin of rifling. Damage of this type is not cause for condemnation.

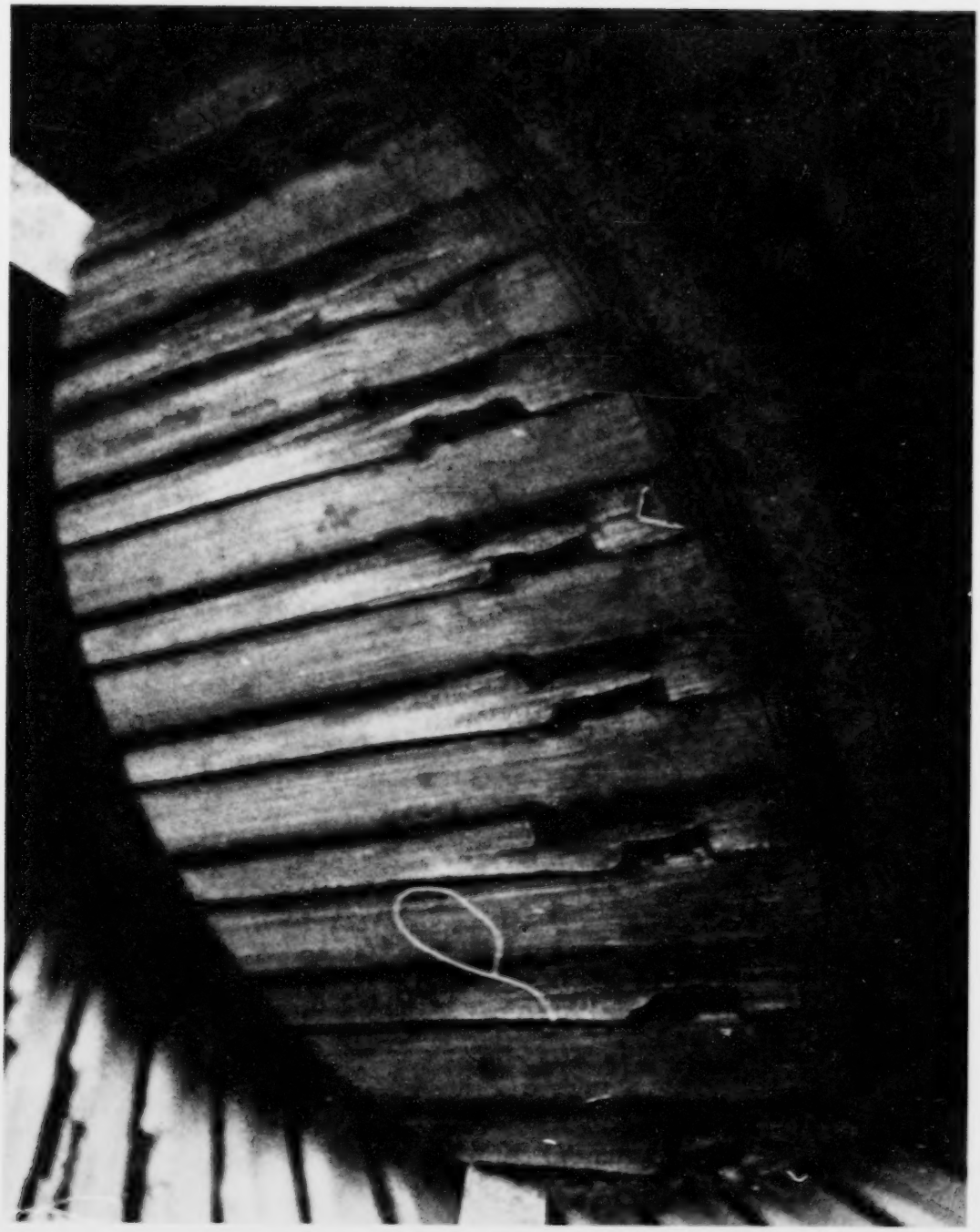


Figure 3-27. Damage to lands up to 10 inches forward of origin of rifling: ACCEPTABLE 155-MM gun cannon, M185.

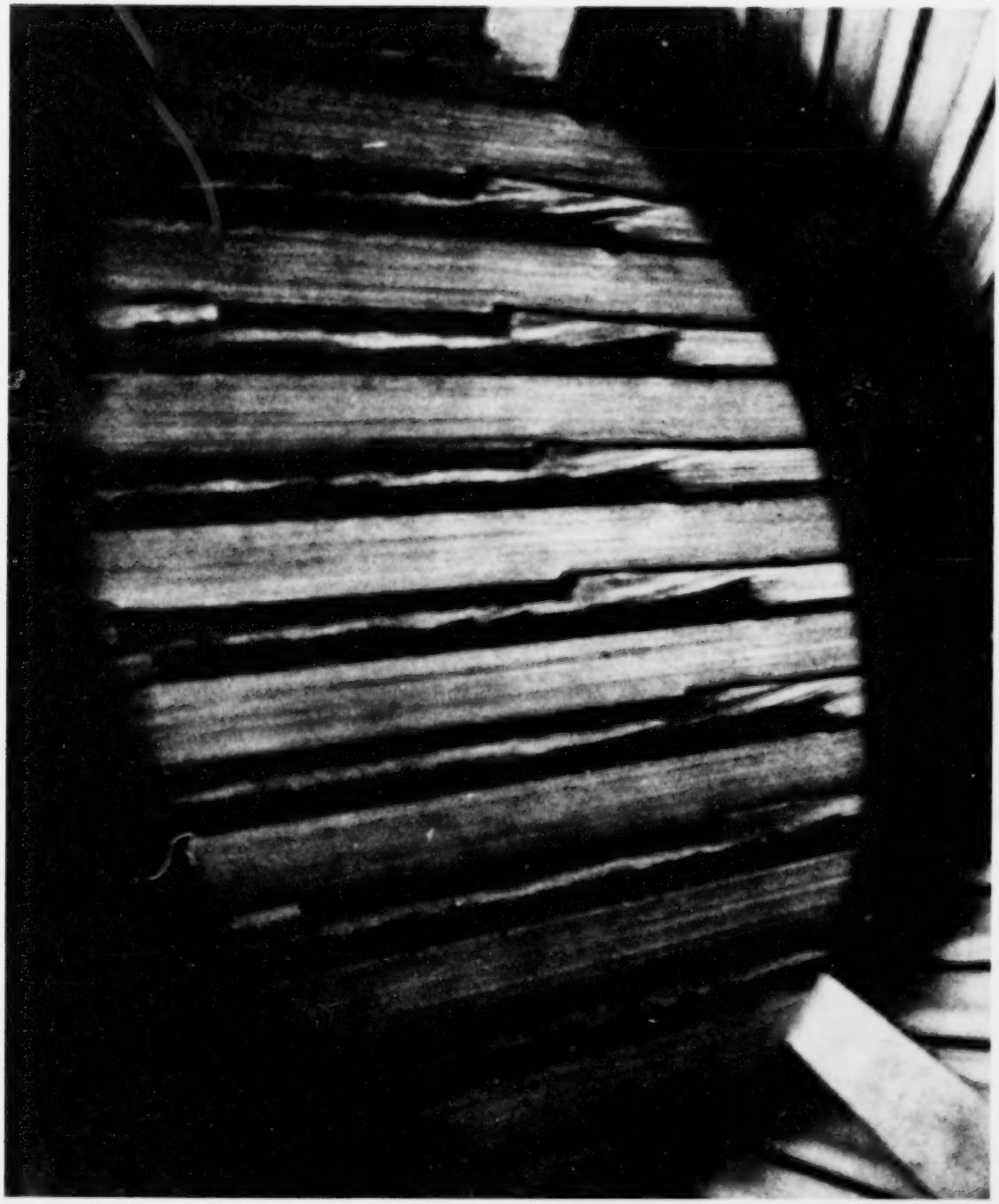
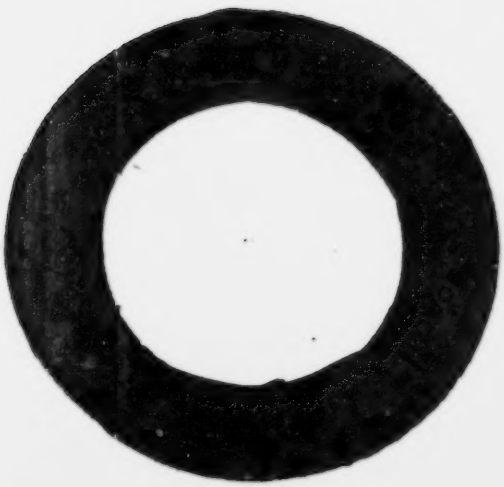


Figure 3-27.1. Damage to lands up to 10 inches forward of origin of rifling: ACCEPTABLE 155-MM gun cannon, M185.



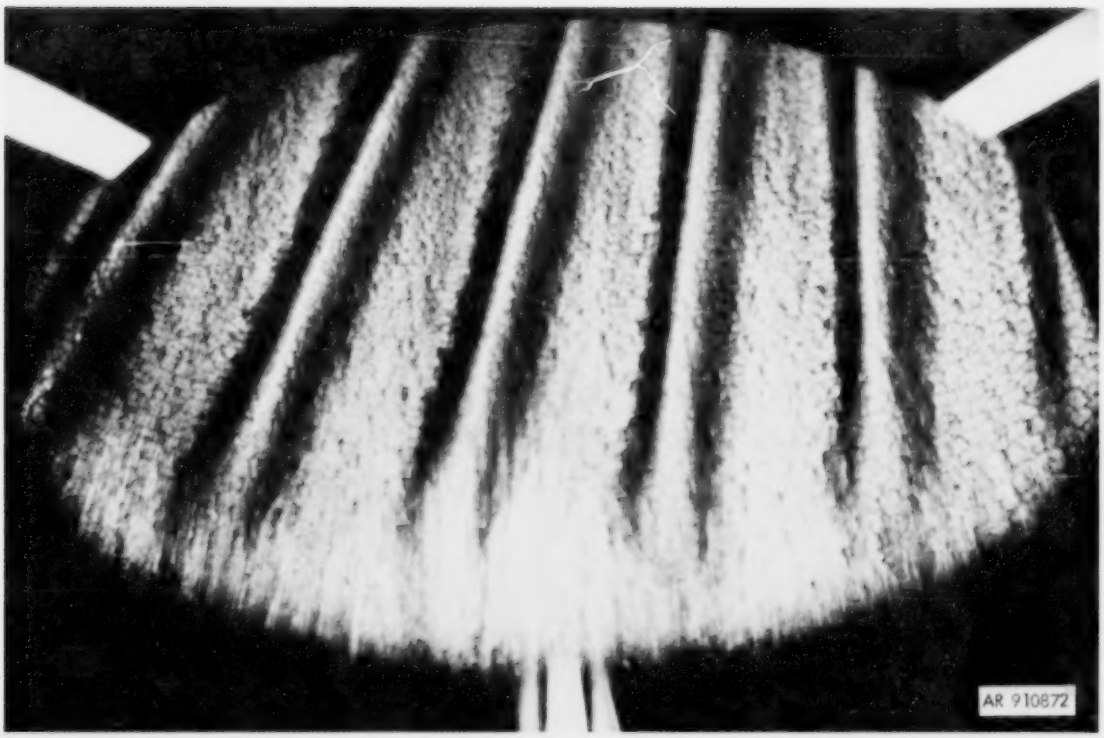
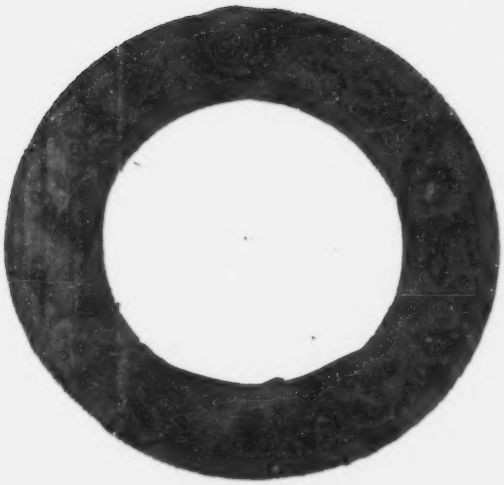


Figure 3-28. Rounded lands near origin of rifling: ACCEPTABLE. 105-MM gun cannon, M68.



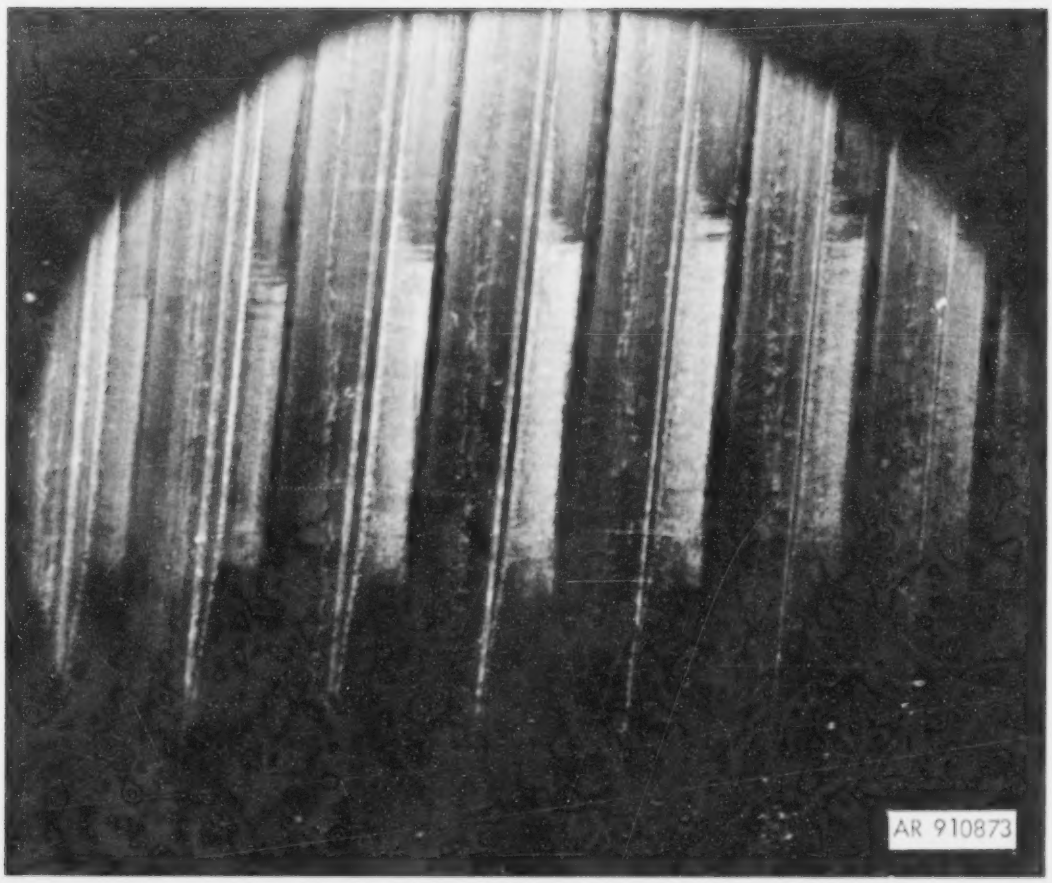
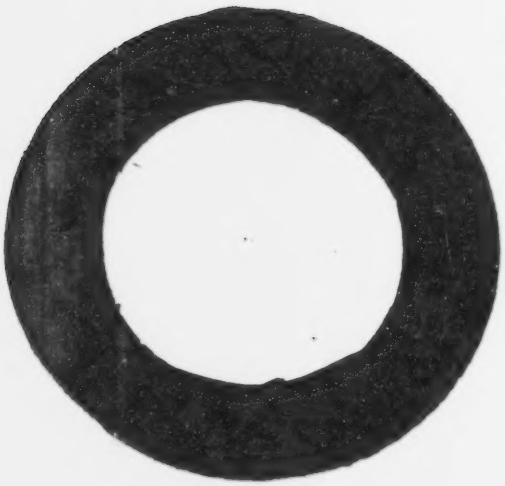


Figure 3-29. Progressive wear of rifling at origin, after 102 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated).



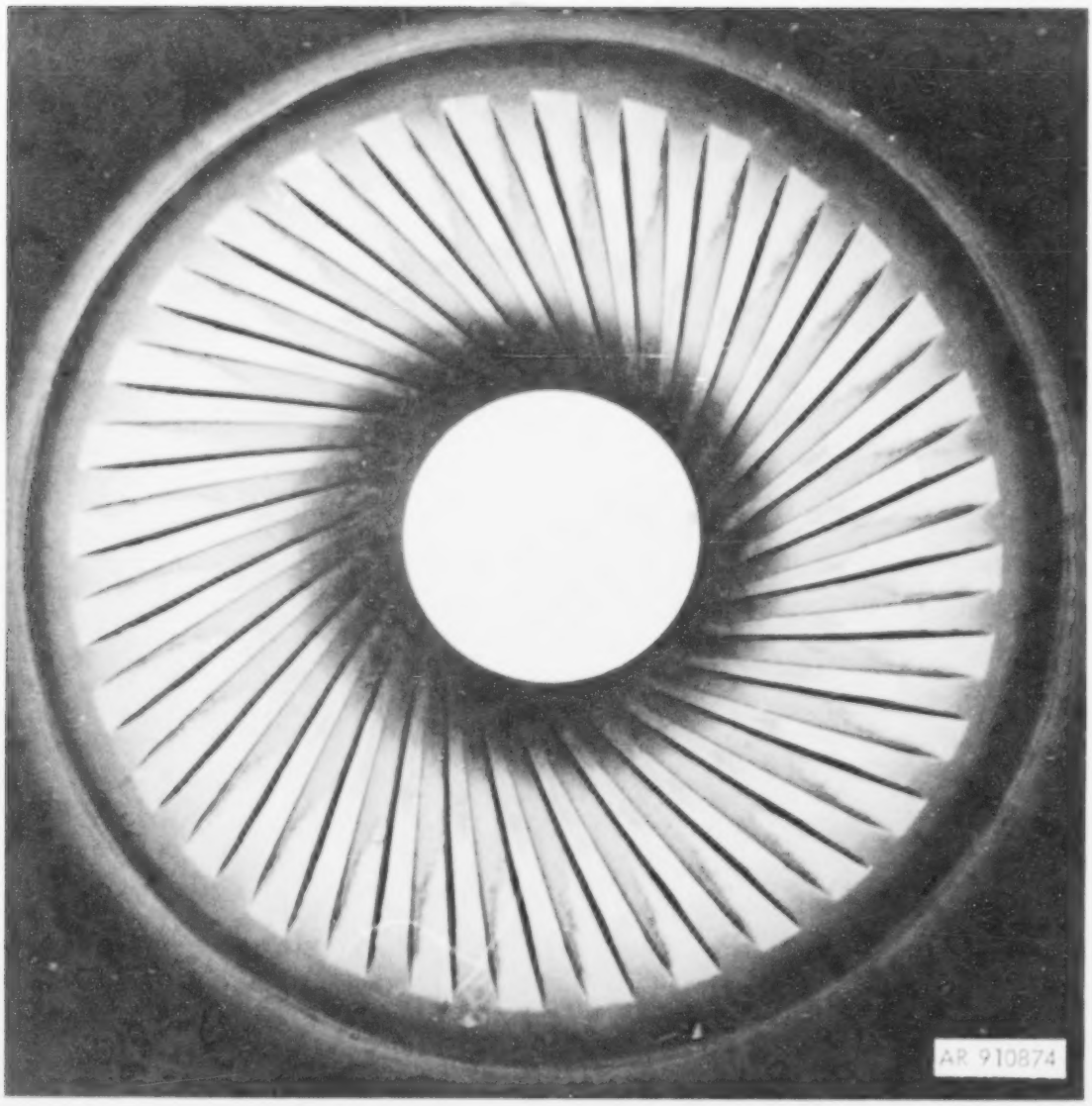
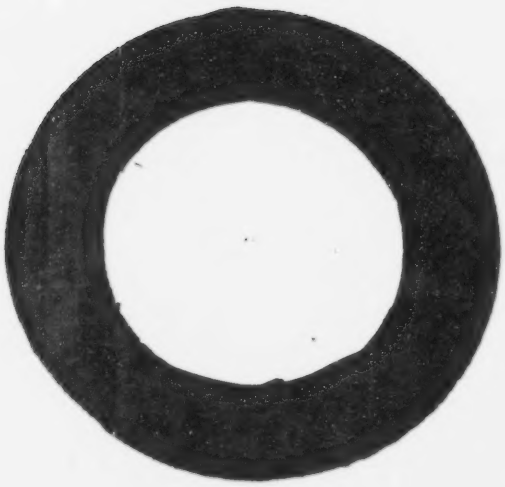


Figure 3-30. Progressive wear of rifling at origin, after 202 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated) end view.



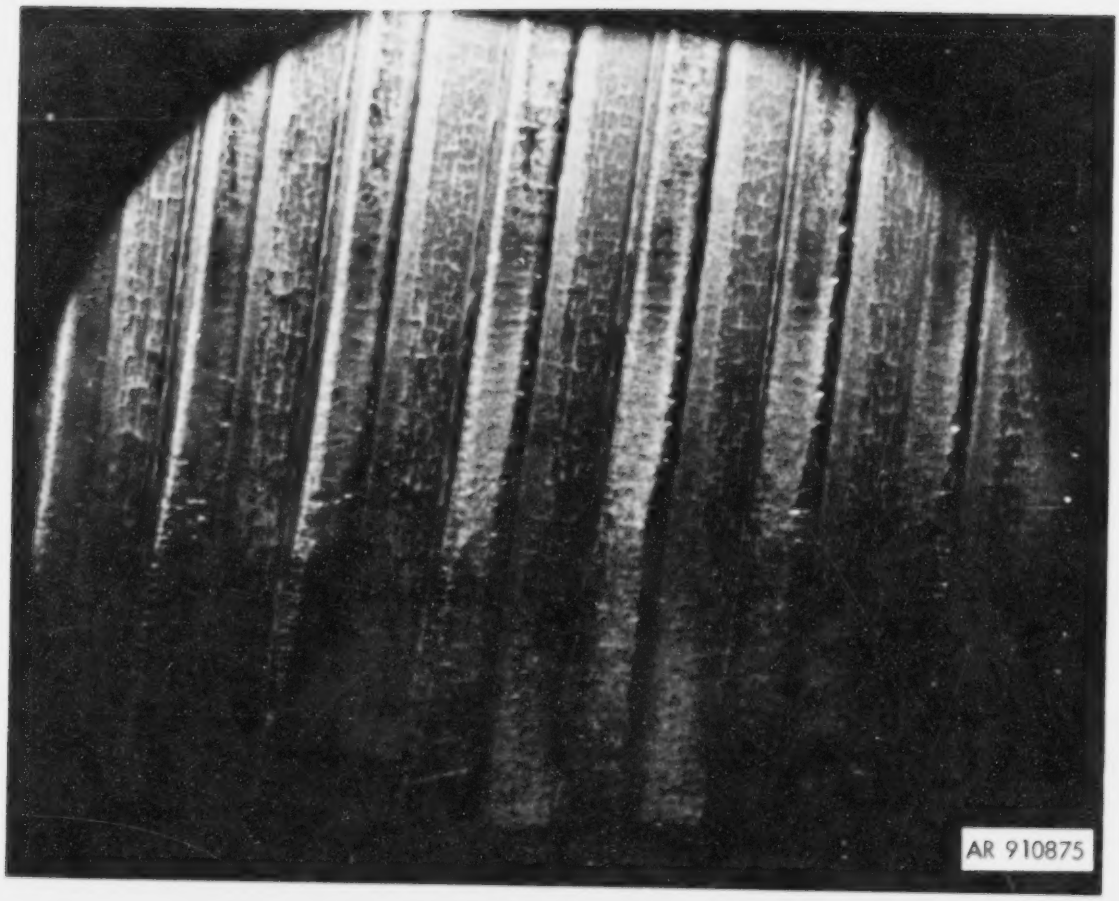


Figure 3-31. Progressive wear of rifling at origin, after 402 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated).

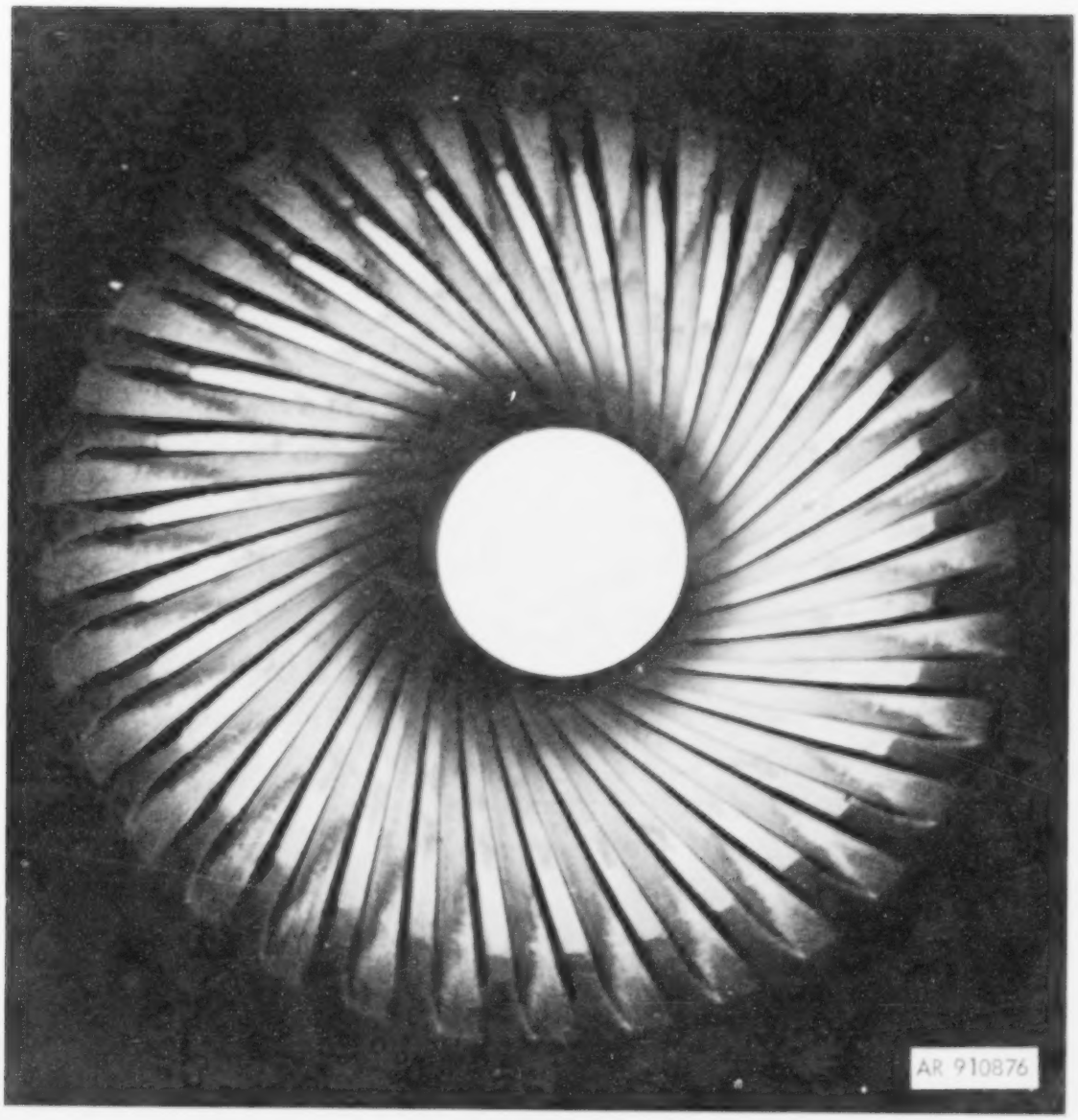
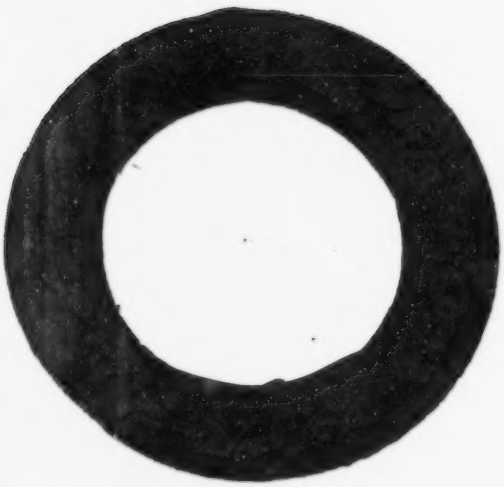


Figure 3-32. Progressive wear of rifling at origin, after 702 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated) end view.



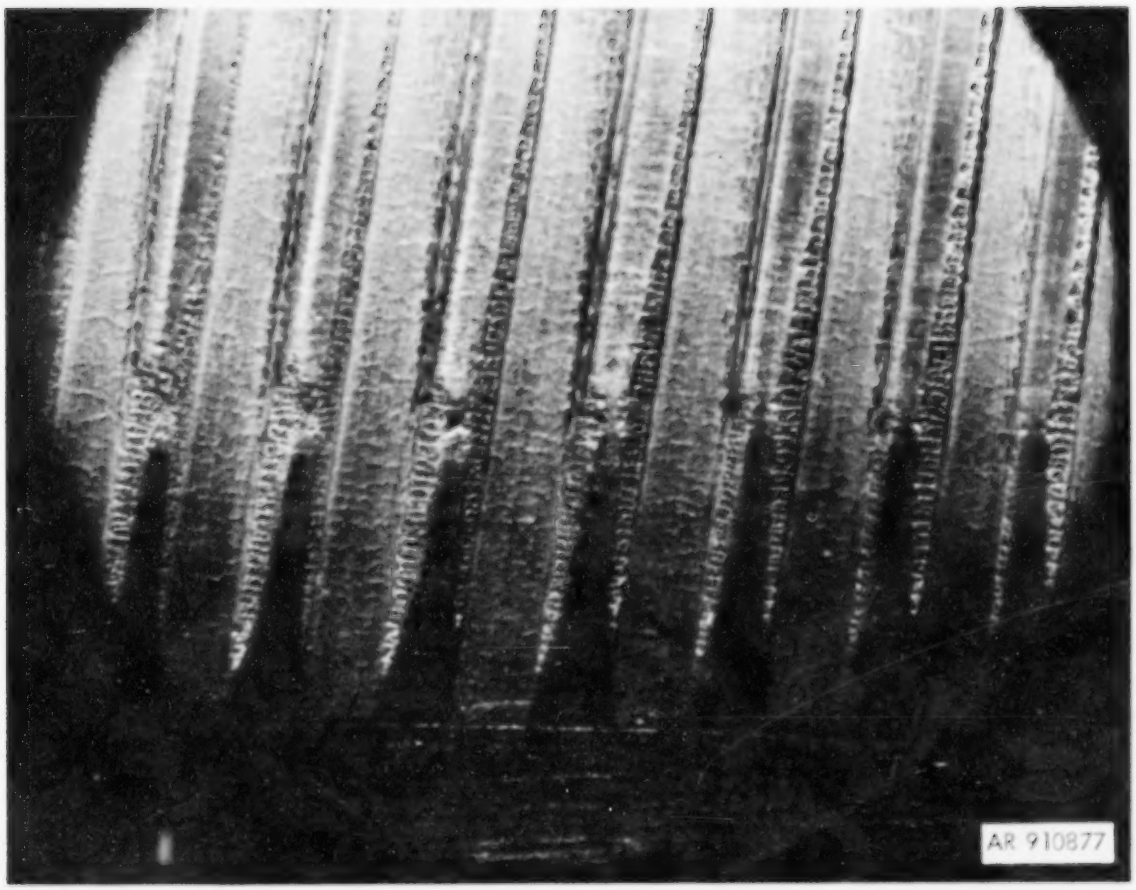


Figure 3-33. Progressive wear of rifling at origin, after 702 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated).

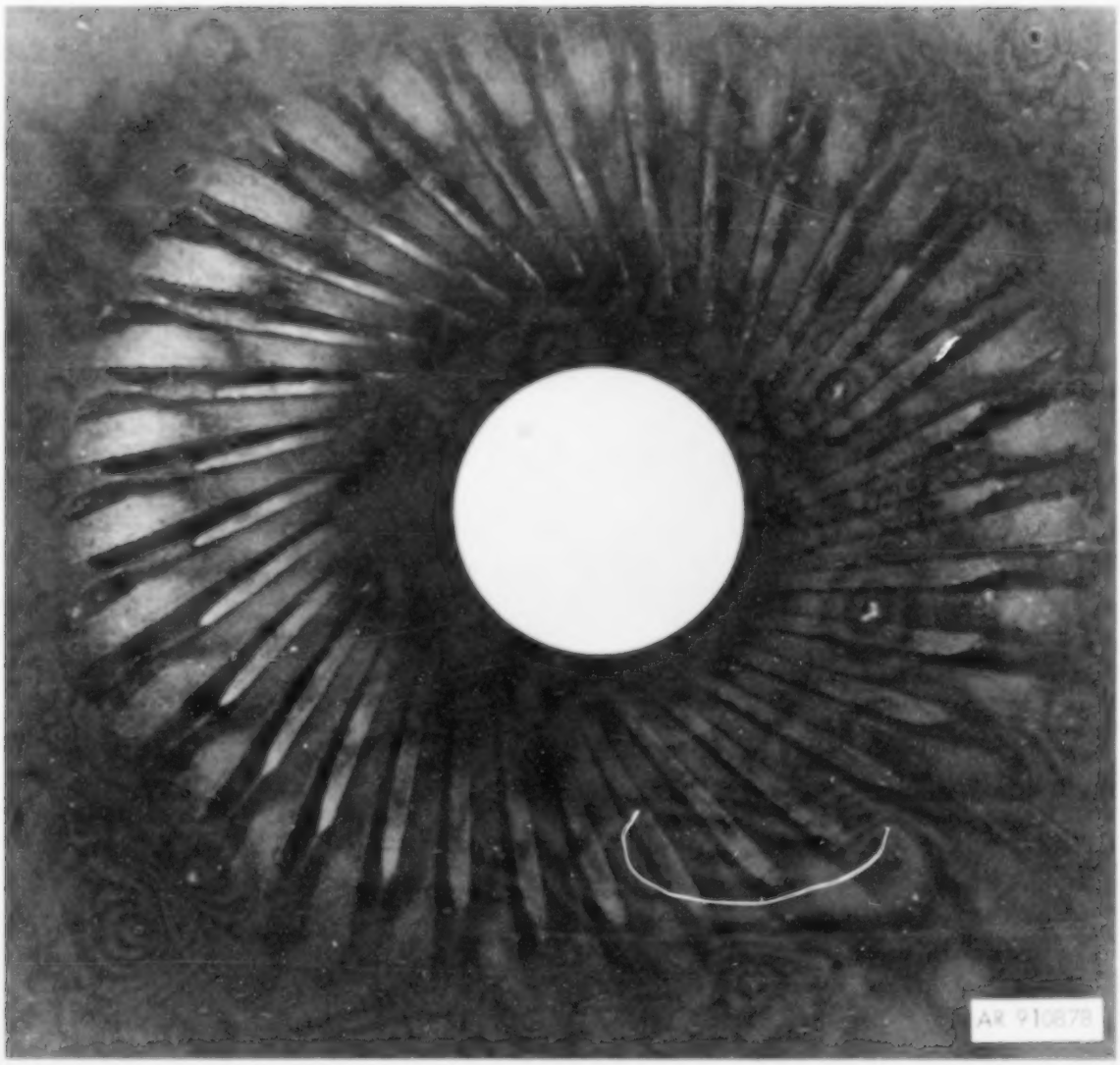
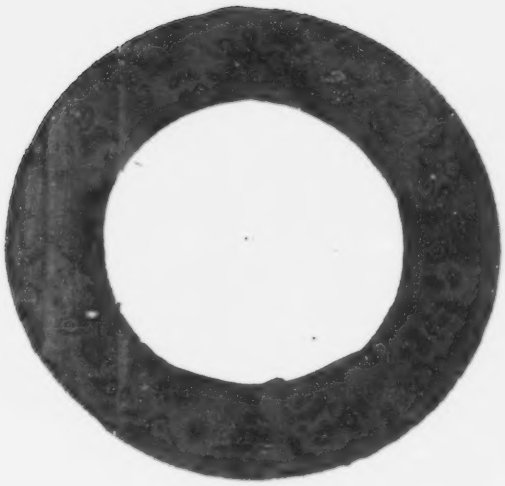


Figure 3-34. Progressive wear of rifling at origin, after 1602 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated) end view.



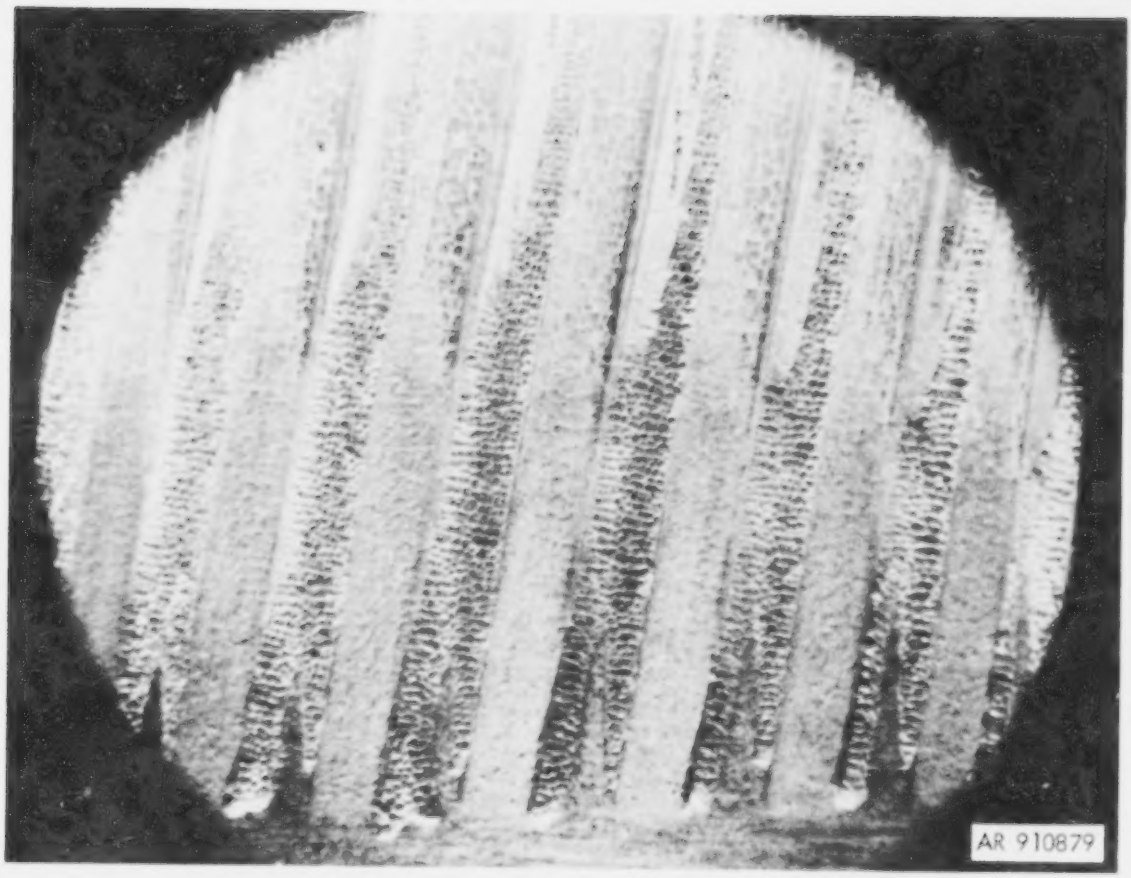


Figure 3-35. Progressive wear of rifling at origin, after 1604 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated).

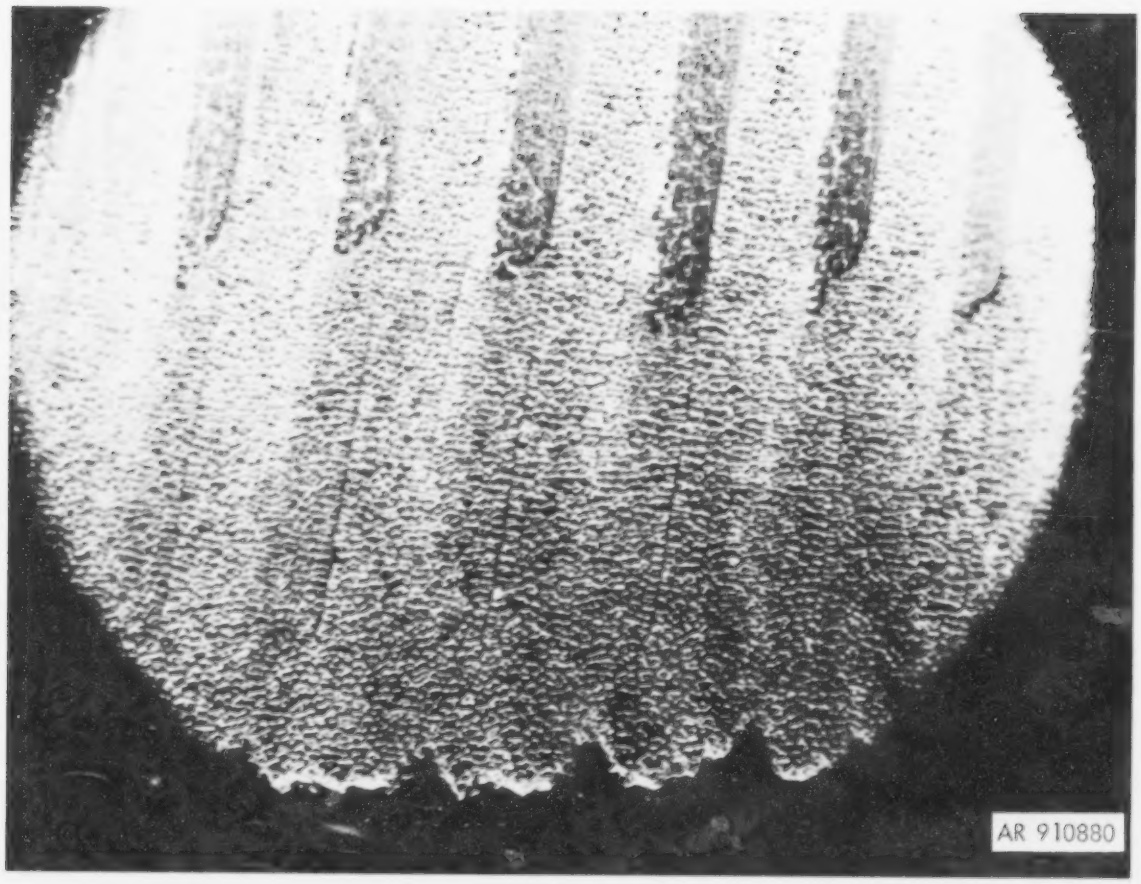


Figure 3-36. Progressive wear of rifling at origin, after 3370 rounds: ACCEPTABLE. 90-MM gun cannon, M41 (chrome-plated).

(2) Condemn tube if you find:

(a) Missing ("stripped") or severely damaged lands: On all tubes (except 20-MM Gun M139): Three or more adjacent lands regardless of length or location. Also if, damage on lands reaches all around circumference and is also as deep as a land at one or more locations on the circumference. Also on 152-MM Gun Launcher, two or more lands alongside the missile slot (fig 3-37 through 3-44).

(b) Stripping of one land more than 20mm (0.8-inch) long or deeper than the groove, or stripping of any six or more lands on 20-MM Gun, Automatic, M139, tube (fig 3-45 through 3-49).

(c) Any rifling damage (other than a raised land) which may result in a shearing or stripping of projectile's rotating band, or any evidence that such has occurred (evidenced by sudden extremely short ranges during firing).

(d) Stripping or spalling of one or more grooves between lands (fig 3-50, 3-51 and 3-52).

e. Deleted.

f. Heat Checks and Scores (Heavy Scratches). Heavy heat checks and scores require extra careful examination, using borescope and different angles to determine if they have become cracks (fig 3-53, 3-55, 3-56 and 3-57). If they are not cracks but are over 1-1/2-inches long, record them, describing lengths plus axial and circumferential locations and add a note: "At next inspection, measure these heat checks or scores. If one has grown, condemn tube."

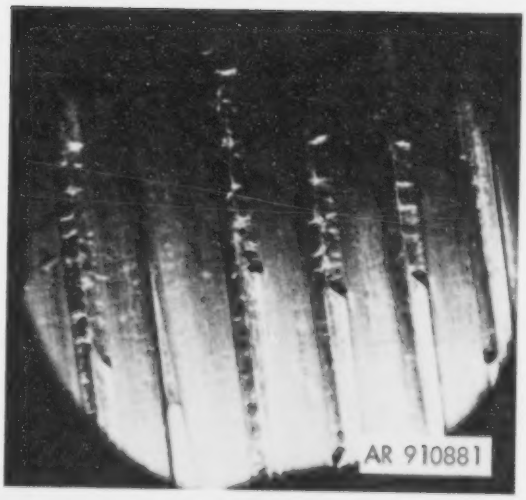


Figure 3-37. Many stripped lands: CONDEMN. 152-MM gun launcher.

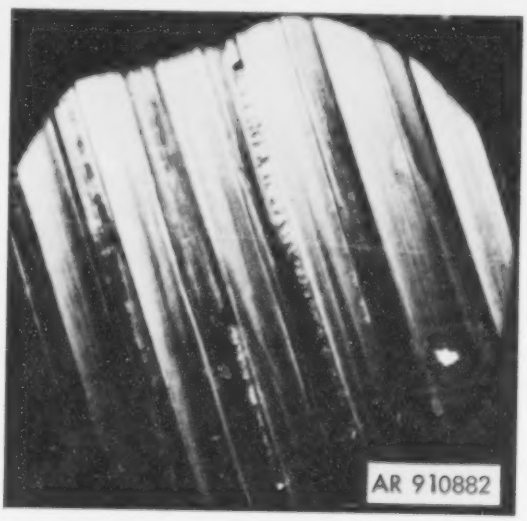


Figure 3-38. Two stripped lands not bordering missile slot: ACCEPTABLE. 152-MM gun launcher.

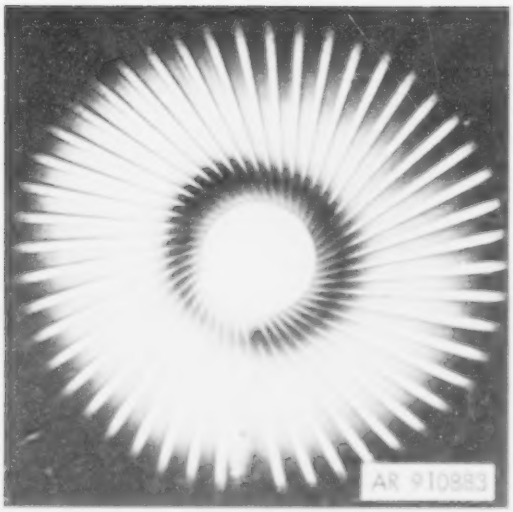


Figure 3-39. One damaged land along side missile slot: ACCEPTABLE. 152-MM gun launcher.

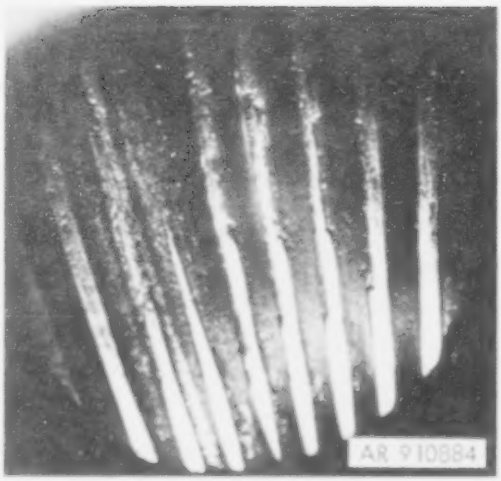


Figure 3-40. Damaged lands along side missile slot: CONDEMN. 152-MM gun launcher.

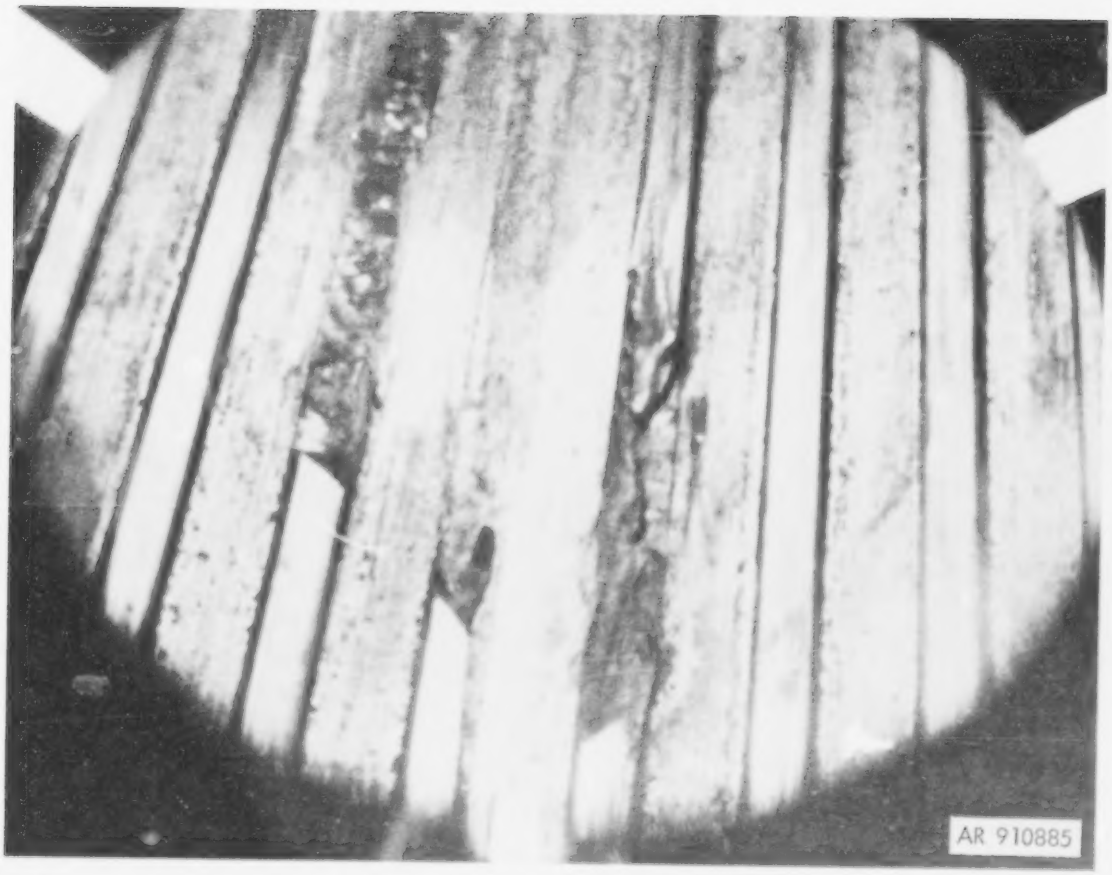


Figure 3-41. Three adjacent stripped lands: CONDEMN, 152-mm gun launcher.

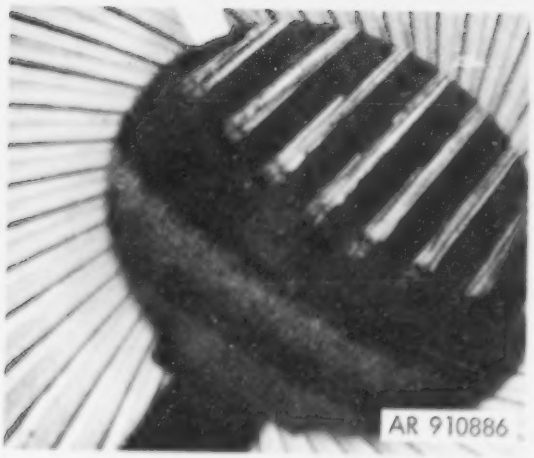


Figure 3-42. Lands partly stripped: ACCEPTABLE. 155-mm howitzer cannon, M1A1.

Figure 3-43. One severely and five lightly damaged lands two feet from muzzle: ACCEPTABLE. 155-MM howitzer cannon, M1A1.

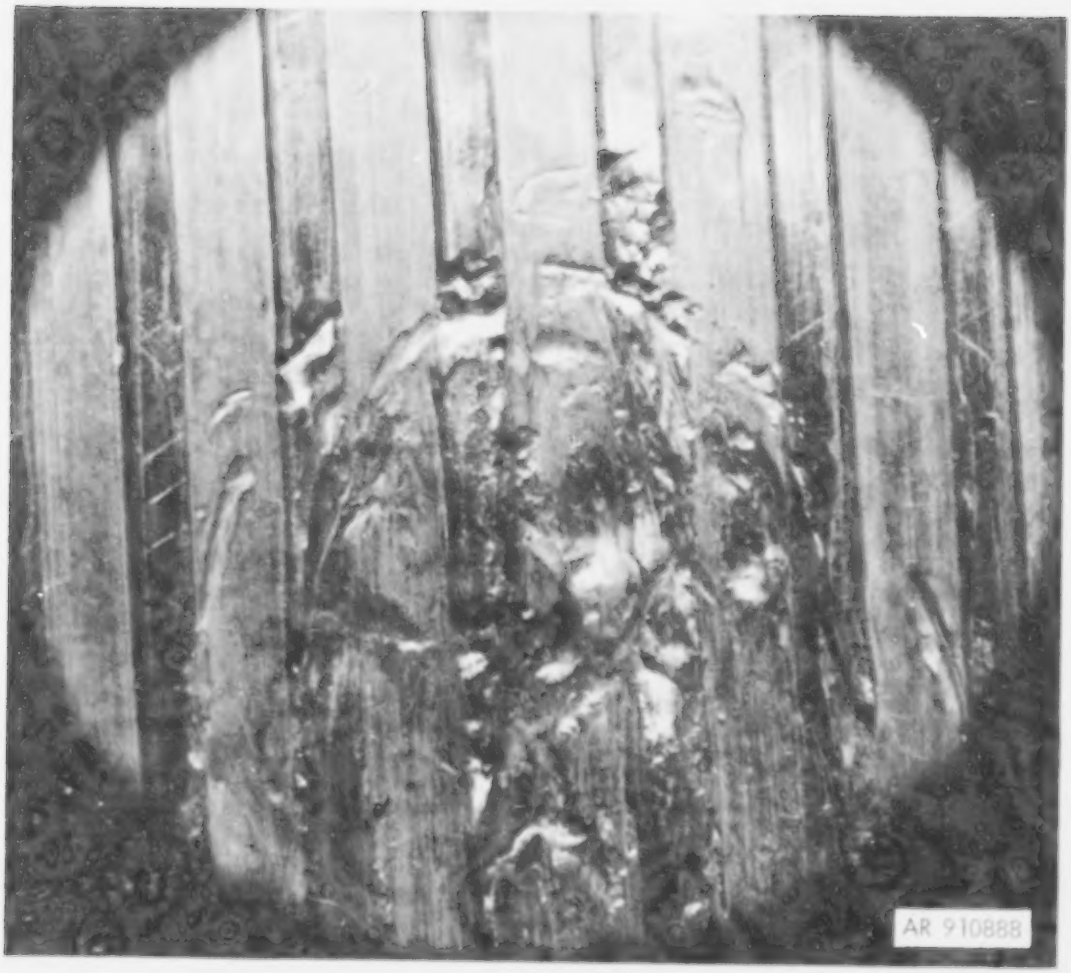


Figure 3-44. Two severely and two lightly damaged lands two feet from muzzle: ACCEPTABLE. 155-MM howitzer cannon, M1A1.

Figure 3-45. Deleted.

All data on pages 3-88 through 3-91/(3-92 Blank), including figures 3-46 through 3-49, deleted.

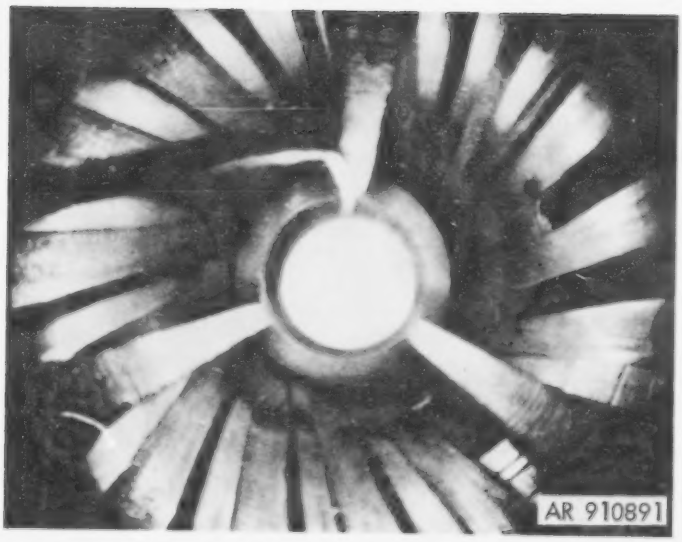


Figure 3-47. Long stripped lands: CONDEMN. 20-MM gun, automatic, M139.

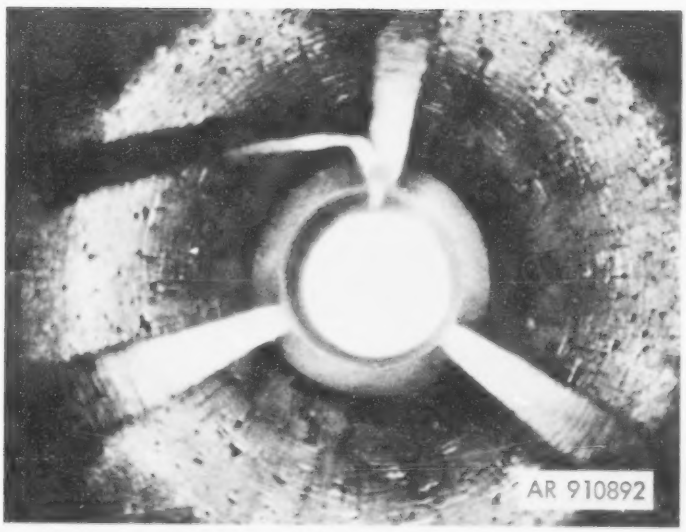


Figure 3-48. Worn chamber: ACCEPTABLE. 20-MM gun, automatic, M139.

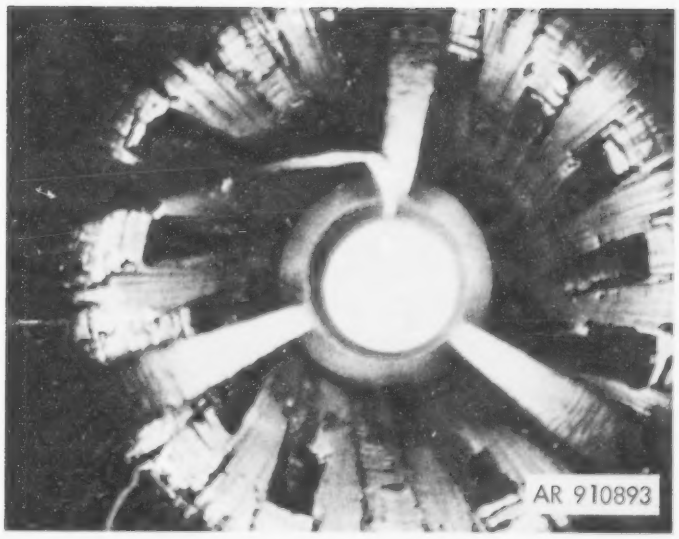
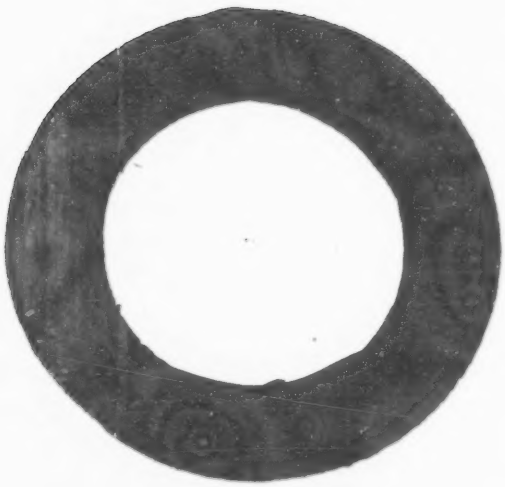


Figure 3-49. Many stripped lands: CONDEMN. 20-MM gun, automatic, M139.



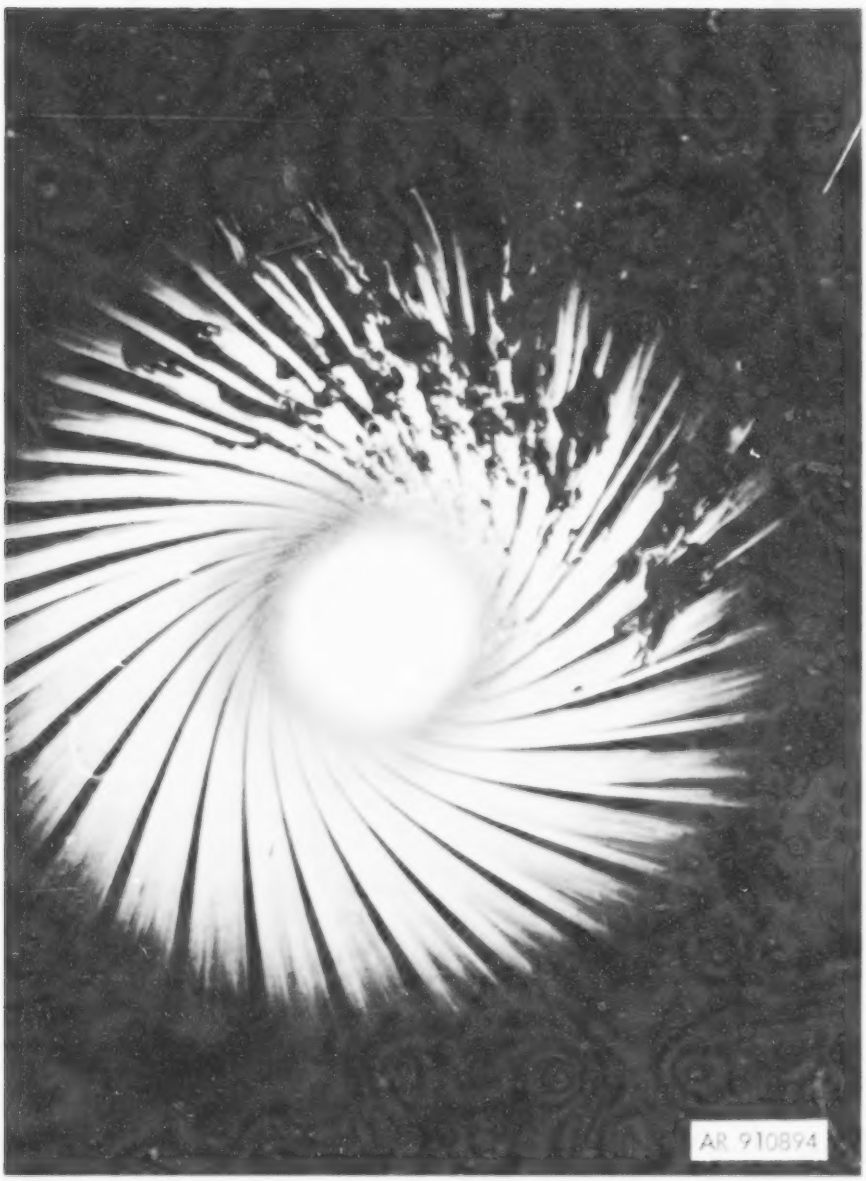


Figure 3-50. Damage to many lands: CONDEMN. 105-MM gun cannon, M68.

Figure 3-51. Three major and four minor damages: CONDEMN. 105-MM gun cannon, M68.

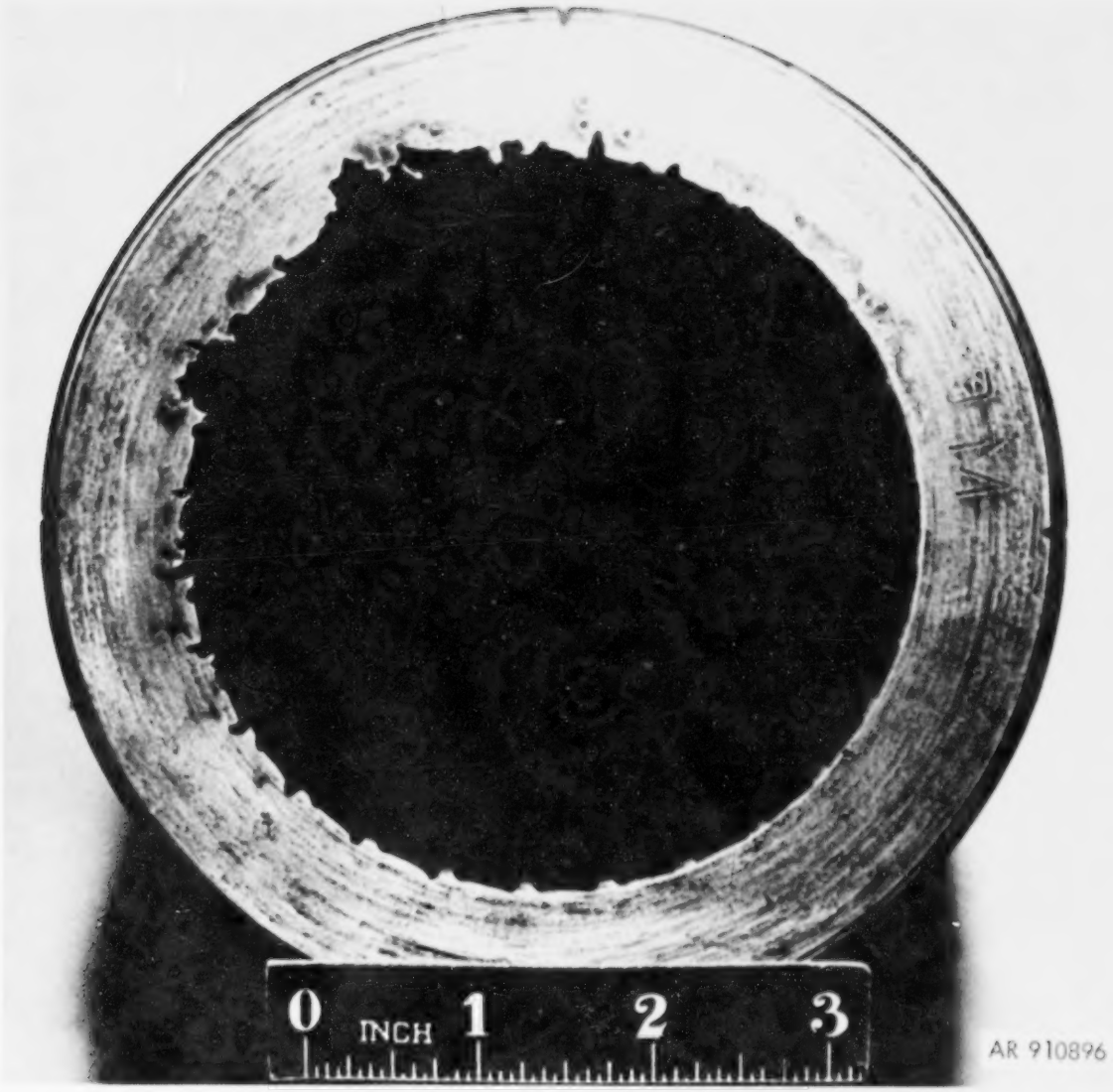


Figure 3-52. Land damage at muzzle: CONDEMN. 105-MM gun cannon, M68.

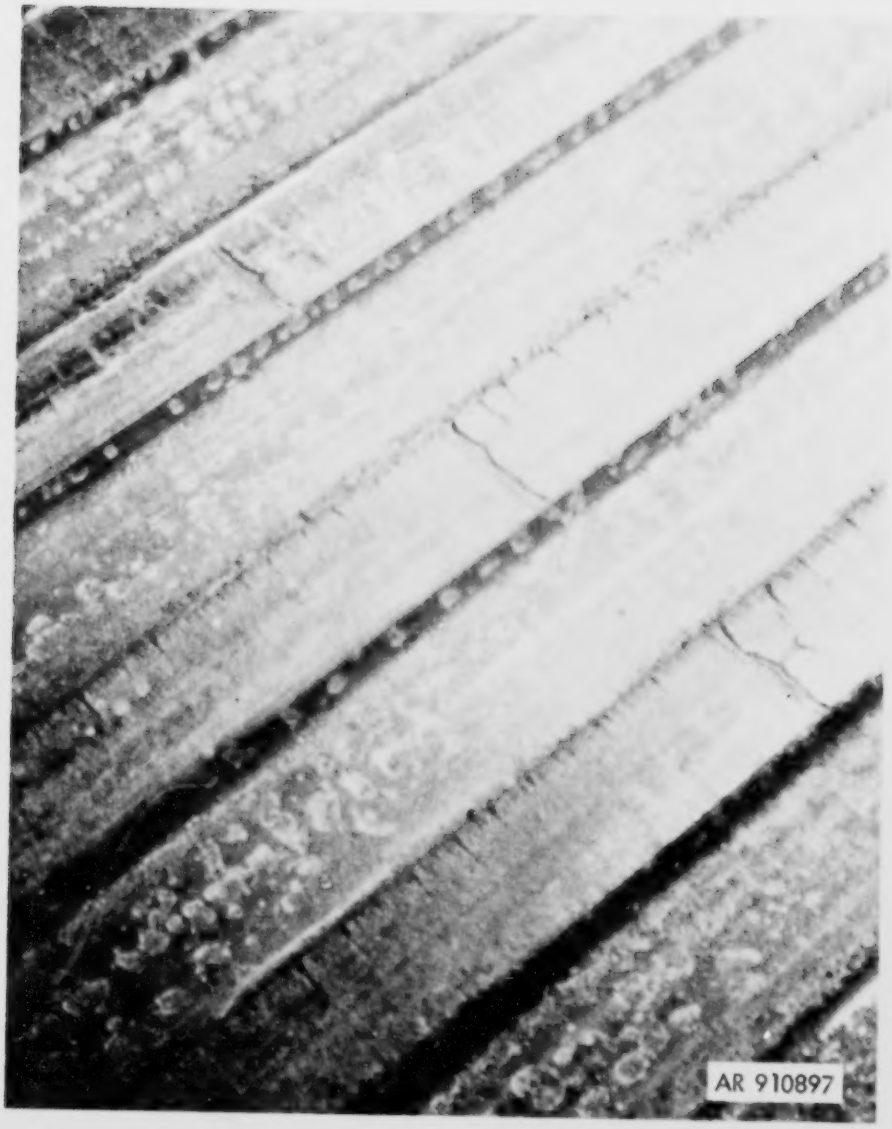


Figure 3-53. Heat checks which only seem to be cracks; ACCEPTABLE.

Figure 3-54. Deleted.

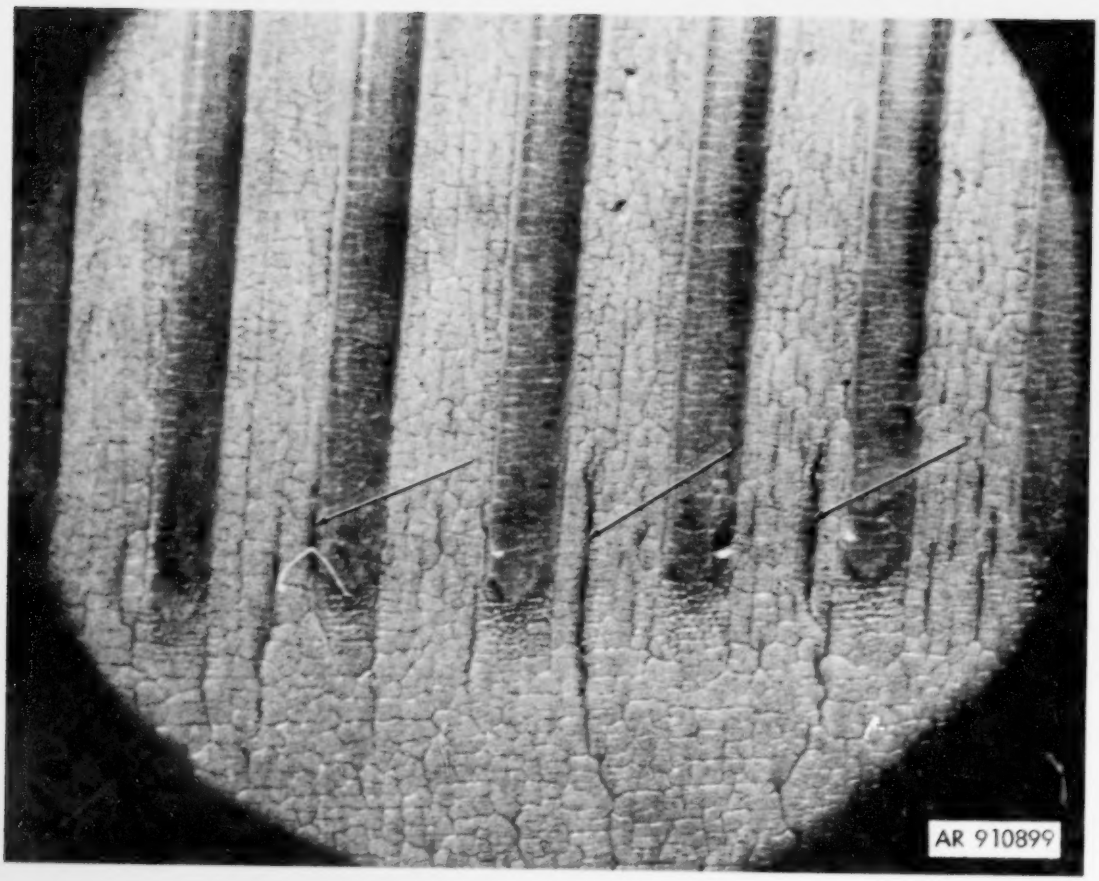


Figure 3-55. Three incipient (future) cracks forming from heat checking: ACCEPTABLE. 155-MM howitzer cannon, M1A1.

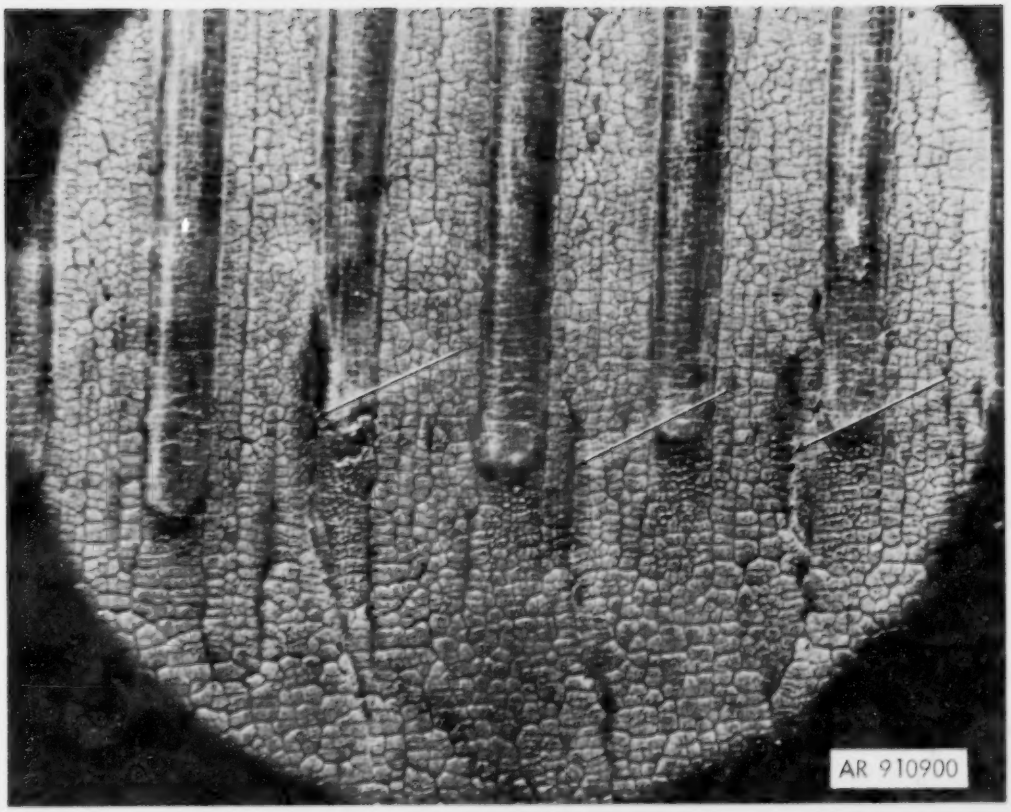


Figure 3-56. Same incipient cracks becoming real cracks: CONDEMN. 155-MM howitzer cannon, M1A1.

g. Manufacturing Defects. Every cannon tube is subject to minor flaws of raw materials, finish imperfections and variations of dimensions within tolerances in manufacture. Superficial surface scratches are accepted, since these are considered negligible in effect. Small gouges in rifling lands are included in this category. Radial tool marks (fig 3-57) affect pattern of heat checking but are not harmful.

h. Internal Gouges, Burrs, Upset Metal, Spalling, Gas Scoring, and Erosion.

CAUTION

Check very carefully to ascertain that a crack has not developed from one of these.

(1) Condemn tube if an internal gouge, spall, or erosion covers a complete circumferential area and is as deep as one land at any one location or if it cuts into a groove between lands or if a land is stripped deeper than a groove (fig 3-58 and 3-59).

(2) Remove burrs and upset metal, using an abrasive no coarser than 200 grit.

(3) Gas scoring is a longitudinal streak or trough eroded into tube near origin of rifling (fig 3-60, 3-61 and 3-62). Condemn tube if it has lost accuracy, which heavy gas scoring causes.

i. External Gouges. Gouges less than 0.1 inch in depth or 1/2 caliber in length are acceptable. If the gouge is deeper or longer, it should be reported to the responsible design activity for disposition. Additionally, any gouged tube should be checked for constriction of the bore.

j. Constriction of Bore. Condemn tube if any constriction is found (other than a raised land fig 3-20).

j.1. Land Interruptions. Complete land interruptions are illustrated in figures 3-62.1 thru 3-62.5.

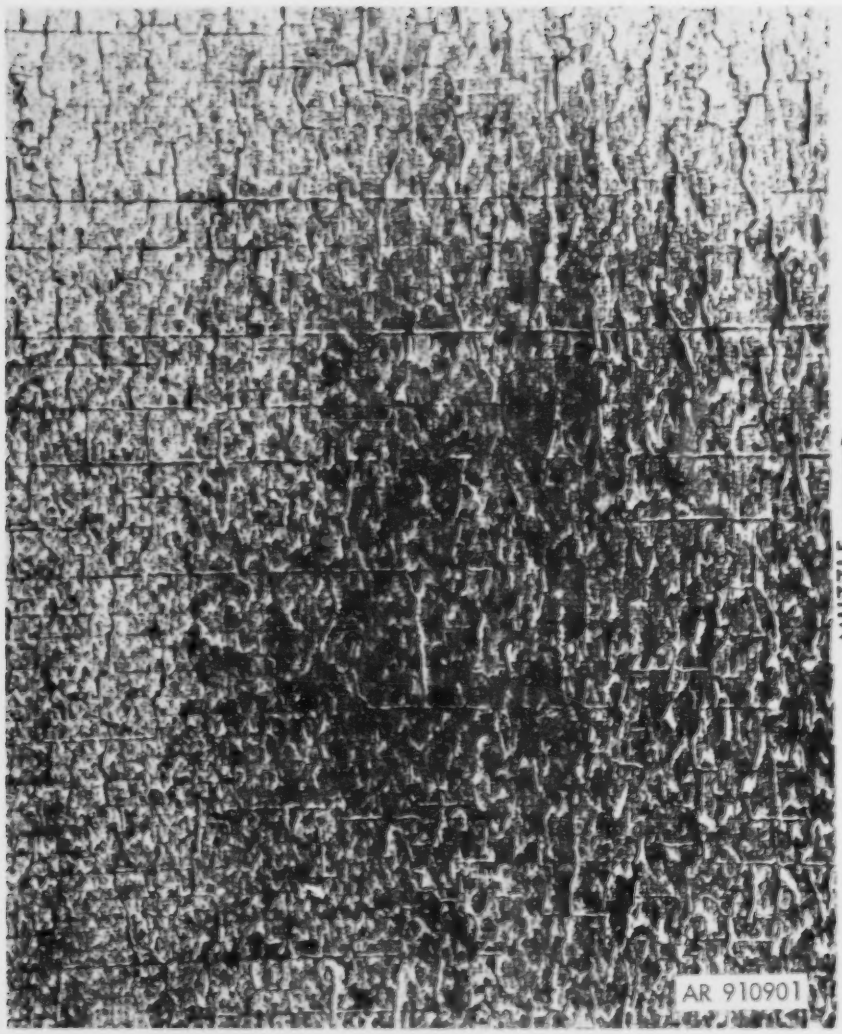


Figure 3-57. Radial tool marks (across heat checking): ACCE

Figure 3-58. Deep spalling across one land and two grooves: CONDEMN. 105-MM gun cannon, M68.

PTABLE.

Figure 3-59. Light indentations caused by fuse wire: ACCEPTABLE.

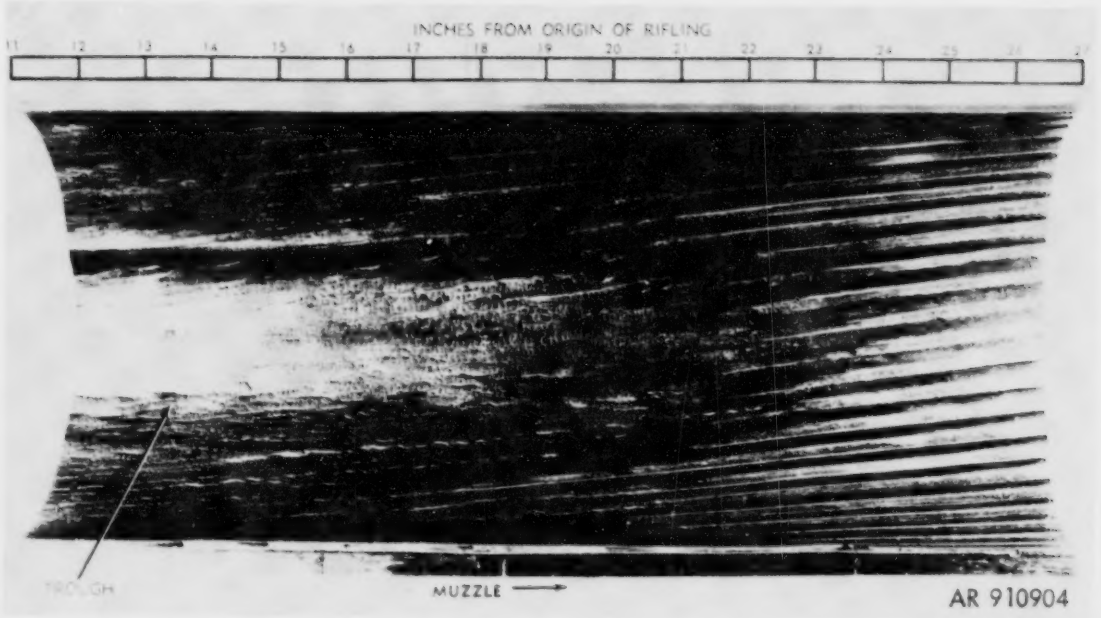


Figure 3-60. Long shallow trough created by linear scoring effect in 155-MM gun cannon, M46.

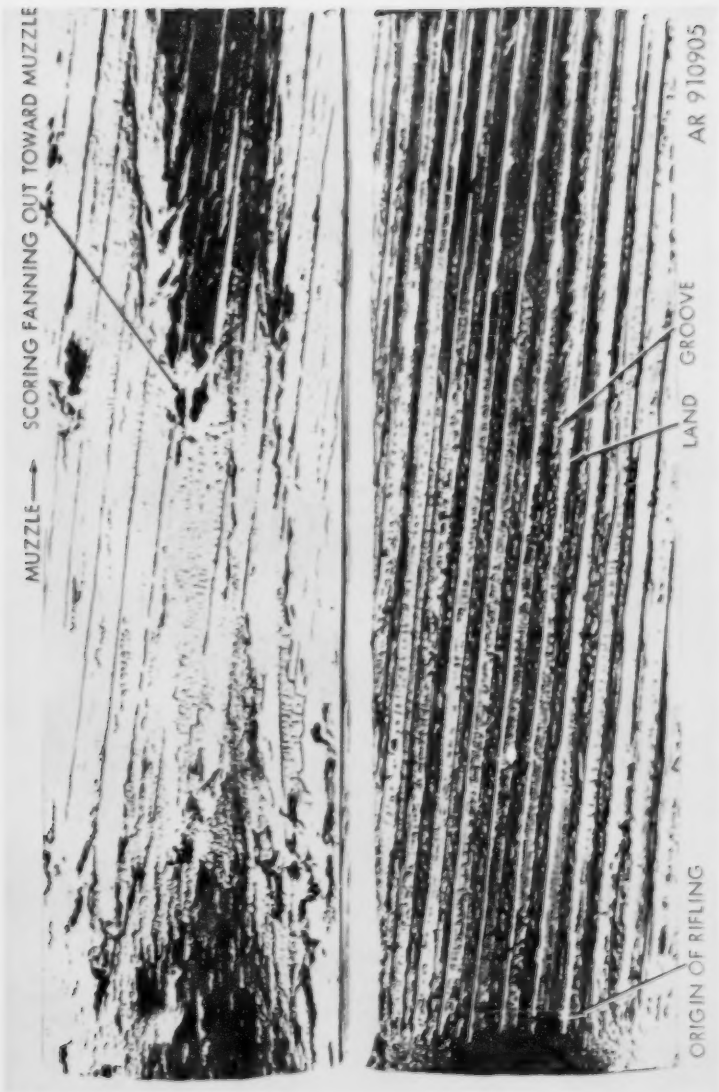


Figure 3-61. Trough created by gas scoring at 12 o'clock (above) and light scoring in grooves at 6 o'clock (below) in 155-MM gun cannon, M46.

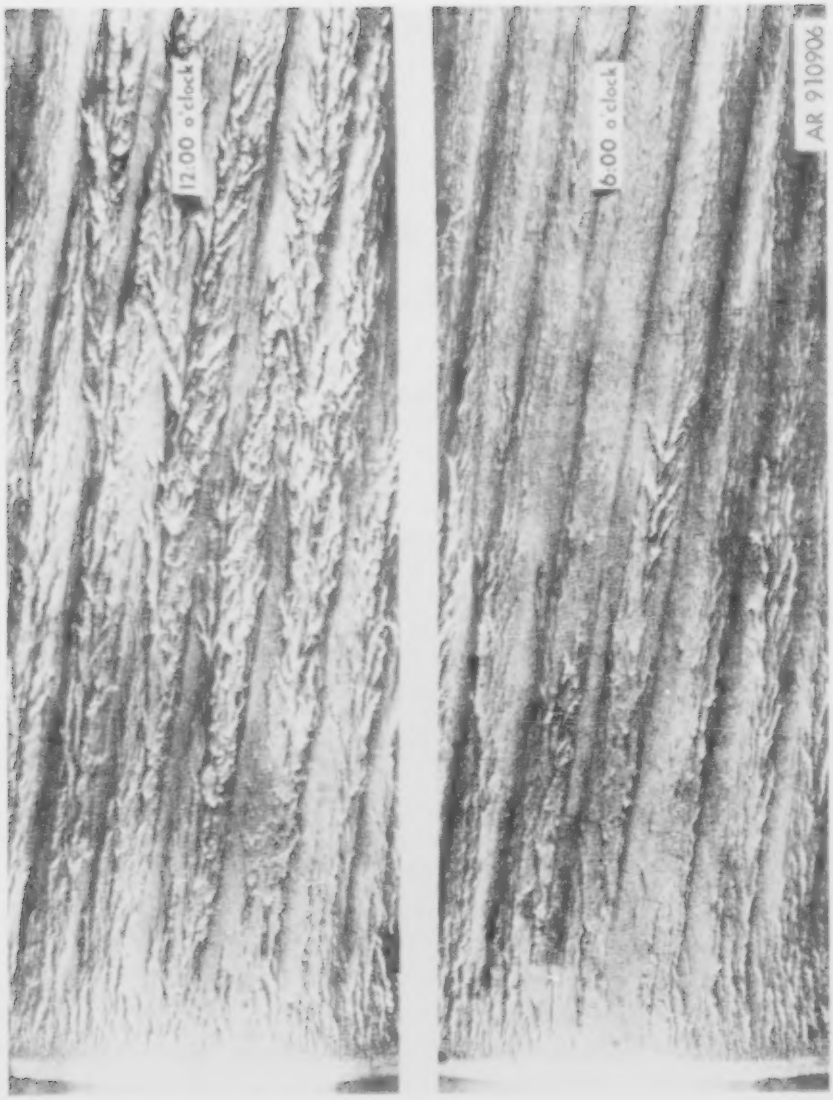


Figure 3-62. Gas scoring in grooves in 105-MM gun cannon, M68/M68A1.

k. Internal Pits (fig 3-53). Condemn tube in accordance with following internal pitting criteria:

Tube Sizes	In Bore	In Chamber	On Gas Check Seat
Under 155-MM	Ignore pitting	Condemn tube if pits cover 20% of entire chamber area or are over 0.010-inch deep	Doesn't apply
155-MM & larger	Ignore pitting	Ignore pitting	See para 3-9m

l. External Pits

(1) Recoil Slide Surfaces--Condemn tube if pitting exceeds any of following external pitting criteria:

Tube	Depth or	Total Slide Surface Area
75-MM, 76-MM, 90-MM, 105-MM Howitzer only, 120-MM, 165-MM	0.015-inch or	20%
105-MM Gun, M68/M68A1	0.020-inch or	50%
120-MM, M256	0.020-inch or	80%
152-MM, 155-MM, 175-MM, 8-Inch	Ignore pitting	

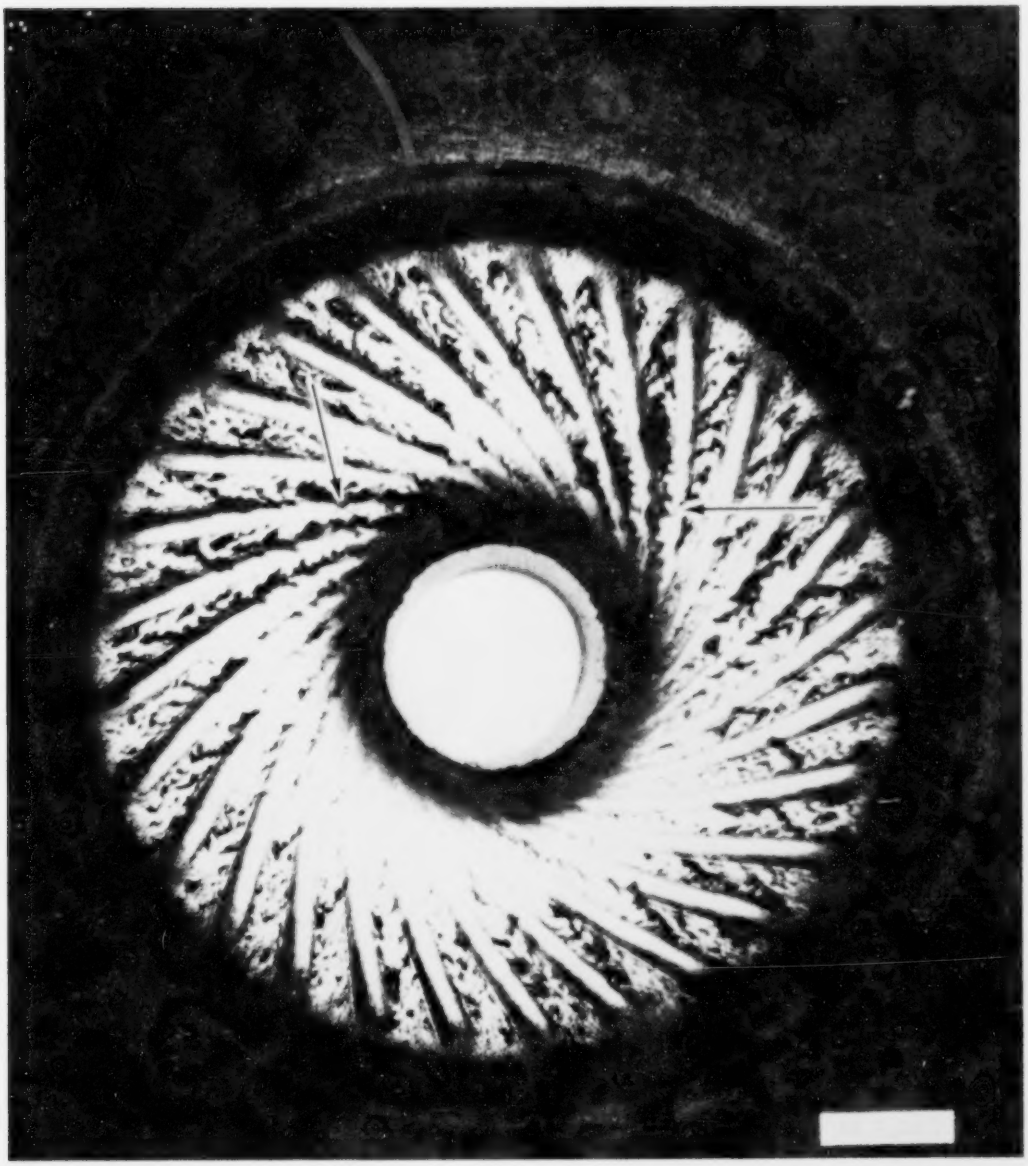


Figure 3-62.1. 105-mm M68 gun tube. View of bore from chamber showing interrupted lands.

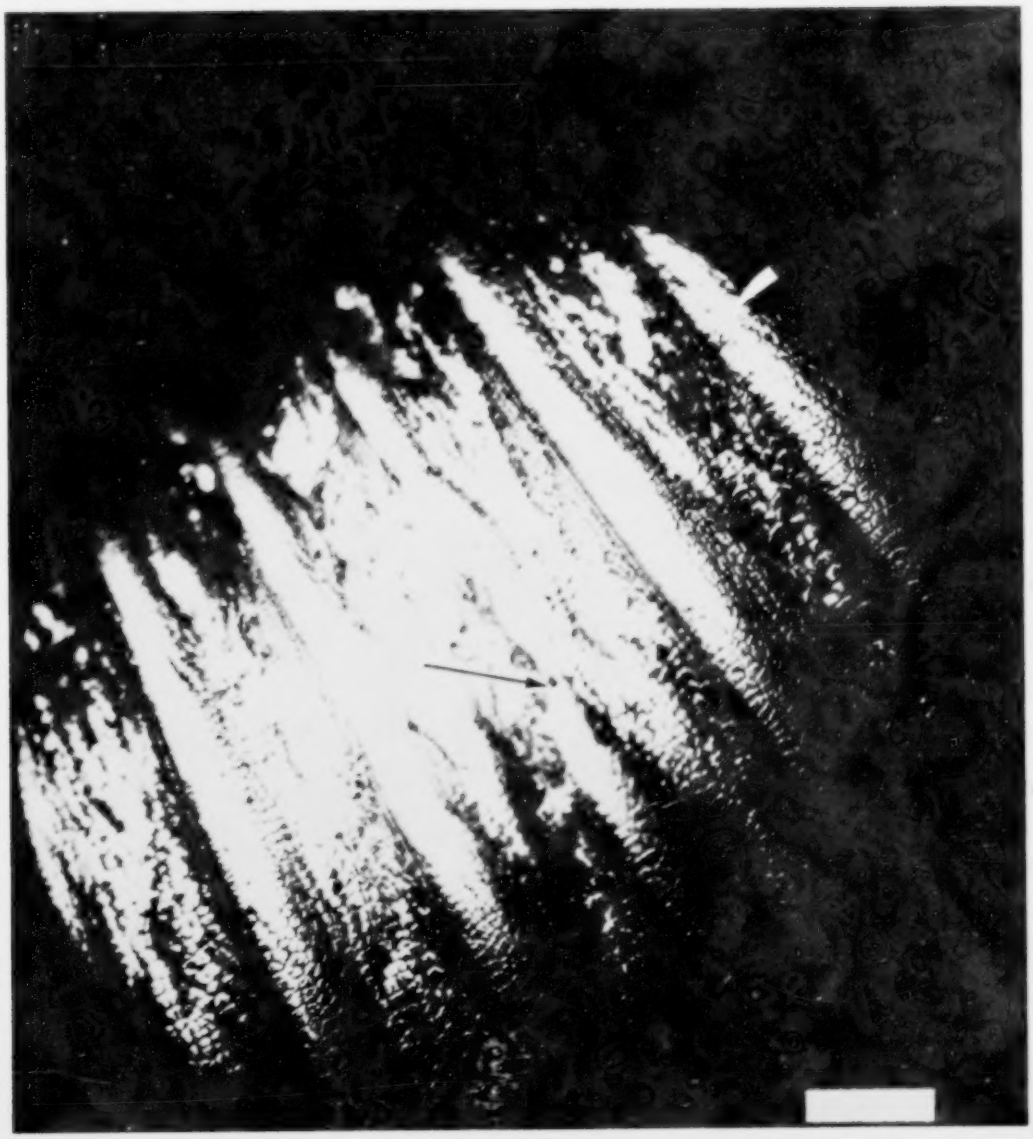


Figure 3-62.2. 105-mm M68 gun tube interrupted lands: CONDEMN. 105-mm M68 only.

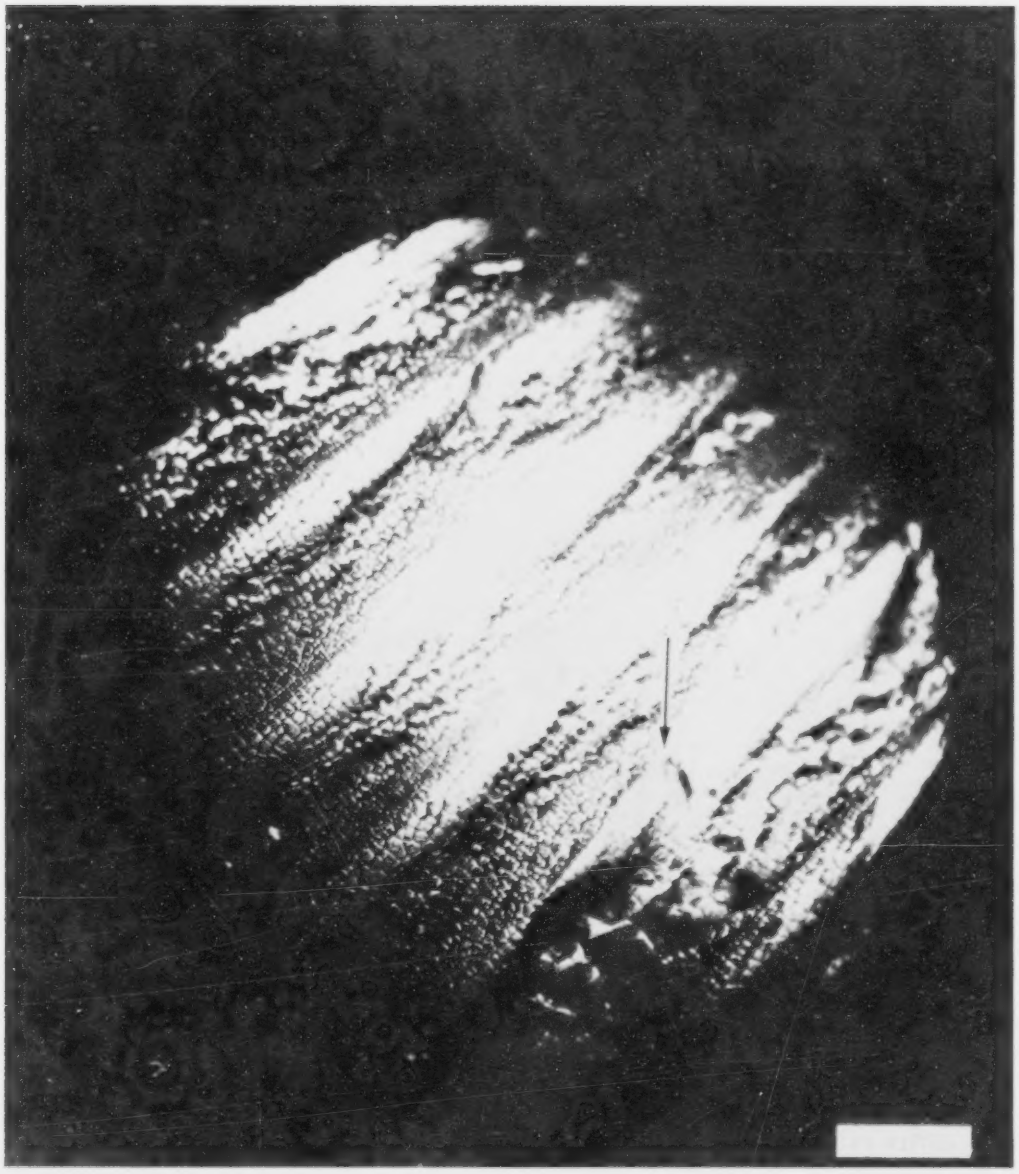


Figure 3-62.3. 105-mm M68 gun tube interrupted lands: CONDEMN. 105-mm M68 only.

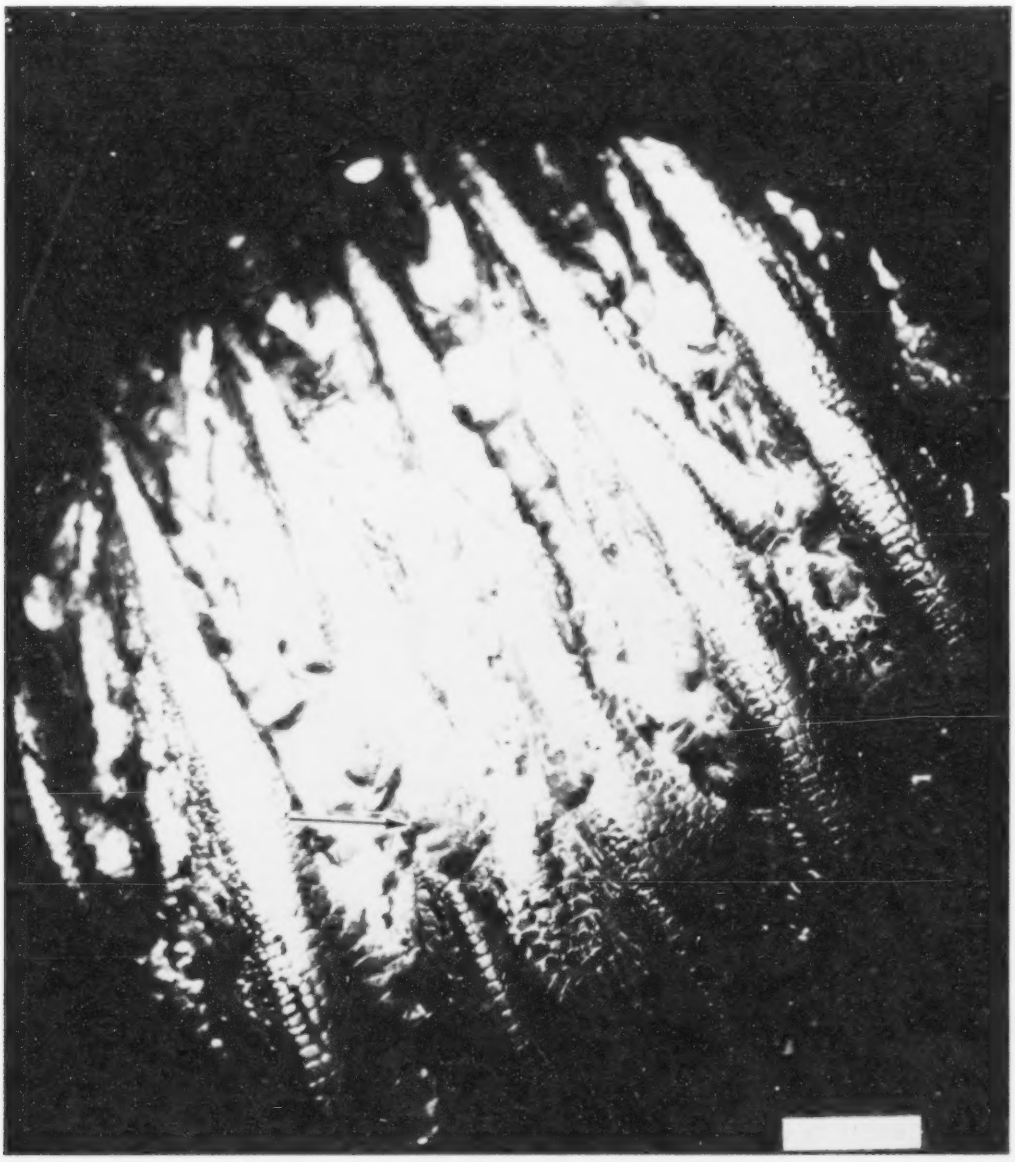


Figure 3-62.4. 105-mm M68 gun tube interrupted lands: CONDEMN. 105-mm M68 only.

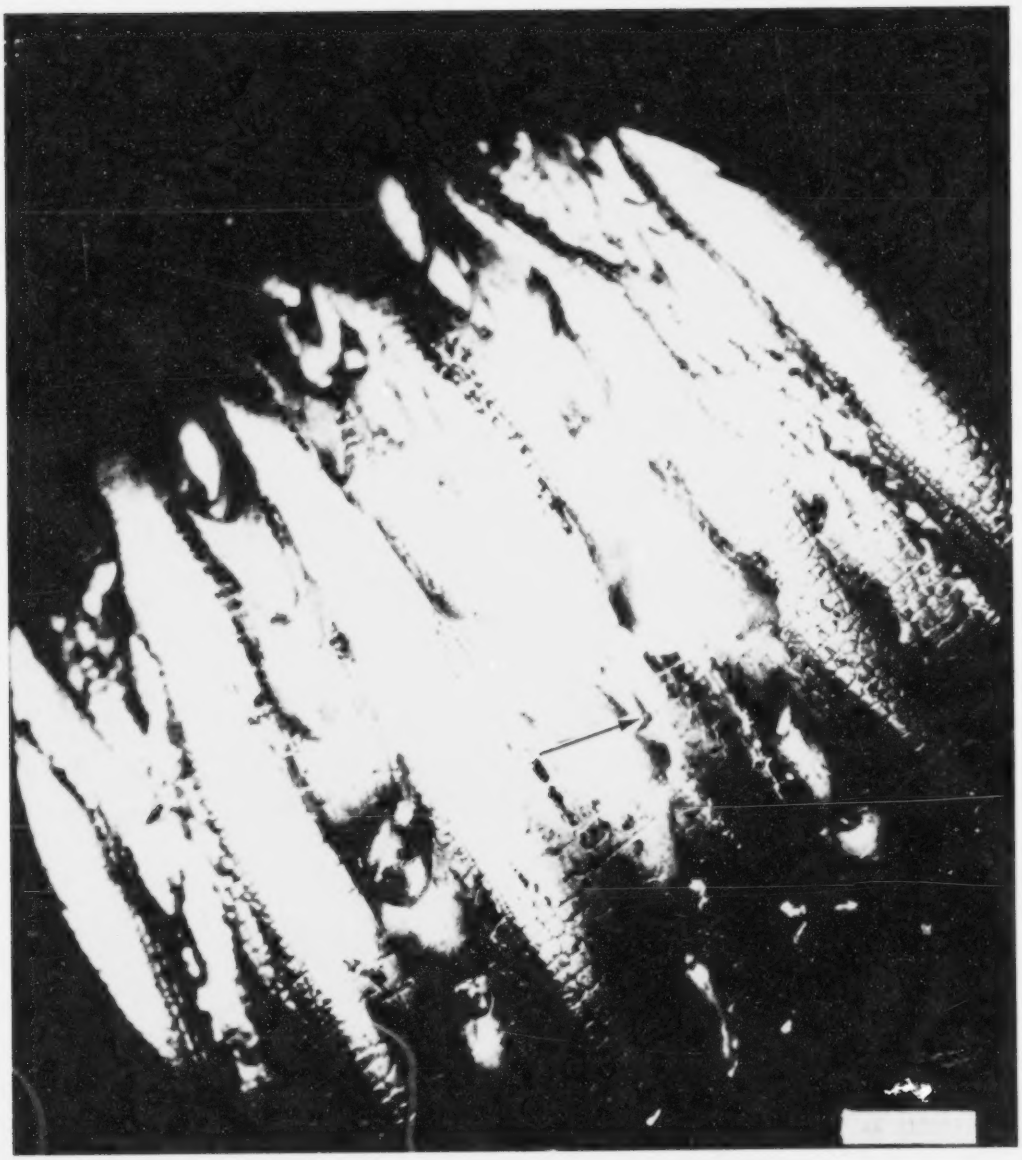


Figure 3-62.5. 105-mm M68 gun tube interrupted lands: CONDEMN. 105-mm M68 only.

(2) Surface under the bore evacuator (fig 2-27 and 2-28)--Condemn tube if pitting exceeds any of following criteria:

Tube	Nonbearing Surface		Bearing Under Each End	
	Depth at any one or more locations	Total area	Depth at any one or more locations	Area each end
105-MM Howitzer, M103	0.040-inch	90%	0.020-inch	20%
105-MM Gun, M68/ M68A1	0.125-inch	80%	*Condemn tube if you see gas leakage during firing or powder streaks or gas erosion path.	
90-MM Gun, M41	0.040-inch	80%	*Condemn tube if you see gas leakage during firing or powder streaks or gas erosion path.	
120-MM Gun, M58 (T123E1)	0.040-inch	80%	*Condemn tube if you see gas leakage during firing of powder streaks or gas erosion path.	
120-MM, M256	0.040-inch	80%	*Condemn tube if you see gas leakage during firing or powder streaks or gas erosion path.	
152-MM Gun Launchers	Ignore pitting			
155-MM Guns and Howitzers	Ignore pitting			

NOTE

Hand remove rust using fine emery cloth.

Restore peened or burred evacuator hole threads.

*This assumes that you've found the evacuator seals to be satisfactory.

m. Gas Check Seat (fig 3-63 through 3-65). Condemn tube if an erosion (gas) path crosses seat and is 0.003-inch or deeper. Condemn tube if gas check seat is so chipped, spalled, peeled, indented, nicked or pitted that it does not make full contact circumferentially (360 degrees) with mating surface on split rings, or its fore and aft mating surface contacts less than 80% of rings' fore and aft surface. To make this inspection, proceed as follows:

Figure 3-63. Groove cut by gas wash across gas check seat: CONDEMN.

Figure 3-64. Gas wash across one obturator split ring. CAREFULLY INSPECT GAS CHECK SEAT.

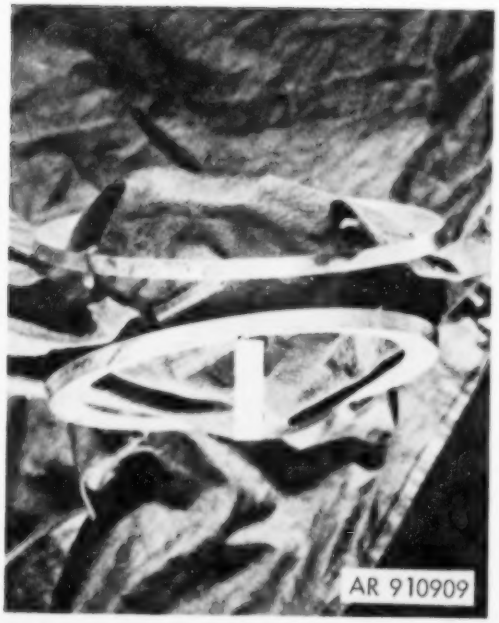


Figure 3-65. Gas wash across obturator split rings. CAREFULLY INSPECT GAS SEAT.

(1) Remove all burrs with a medium India oil stone, or equivalent.

(2) Clean gas check seating surfaces of oil, grease, abrasive or foreign material.

(3) To test for proper seating, lightly coat tube seating surface of the split rings with red lead or prussian blue. Close and lock breech. Open breech and examine the imprint of the red lead or prussian blue on contact area in the tube to determine compliance with preceding requirements.

(4) After inspection, remove red lead or prussian blue from obturator parts and tube seat by wiping with a clean, nonabrasive cloth.

n. Chips Missing From Edges of Lands. Ignore this condition (fig 3-66).

o. Missing Chrome-Plating

(1) Lands and grooves (in 90-MM Gun Cannon, M41 and in some 175-MM Gun Cannon, M113): Ignore missing sheets, flakes or chips (fig 3-66), but inspect carefully for cracks in vicinity.

(2) Chambers (in all 155-MM howitzers): Ignore missing sheets, flakes or chips (fig 3-67 through 3-71).

NOTE:
The loss of small amounts of chrome plate over the life of the gun tube will not affect accuracy or safety of the gun tube.

(3) 120-MM M256 Tube-Stripping, chipping, pitting of chrome plating is acceptable throughout the bore of the tube to the extent illustrated in Figures 3-67, 3-68, 3-69, 3-70, 3-70.1, 3-70.2 and 3-70.3. There are no limitations regarding the number or area size of these. However, erosion into the base metal of the tube is a limiting factor. Once erosion into the base metal occurs, in any area where the chrome has been lost, as illustrated in Figure 3-70.4, Figure 3-70.5, Figure 3-70.6, the depth of the deepest point of erosion shall be measured with the Bore Erosion Gage, P/N 12520840 and recorded at every 150 EFC rounds fired. The tube shall be evaluated in accordance with the criteria of Para 3-8, d.

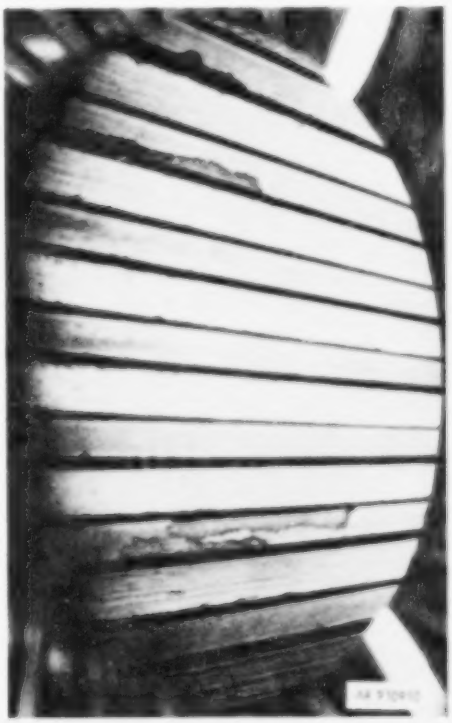


Figure 3-66. Chips missing from edges of lands: ACCEPTABLE.

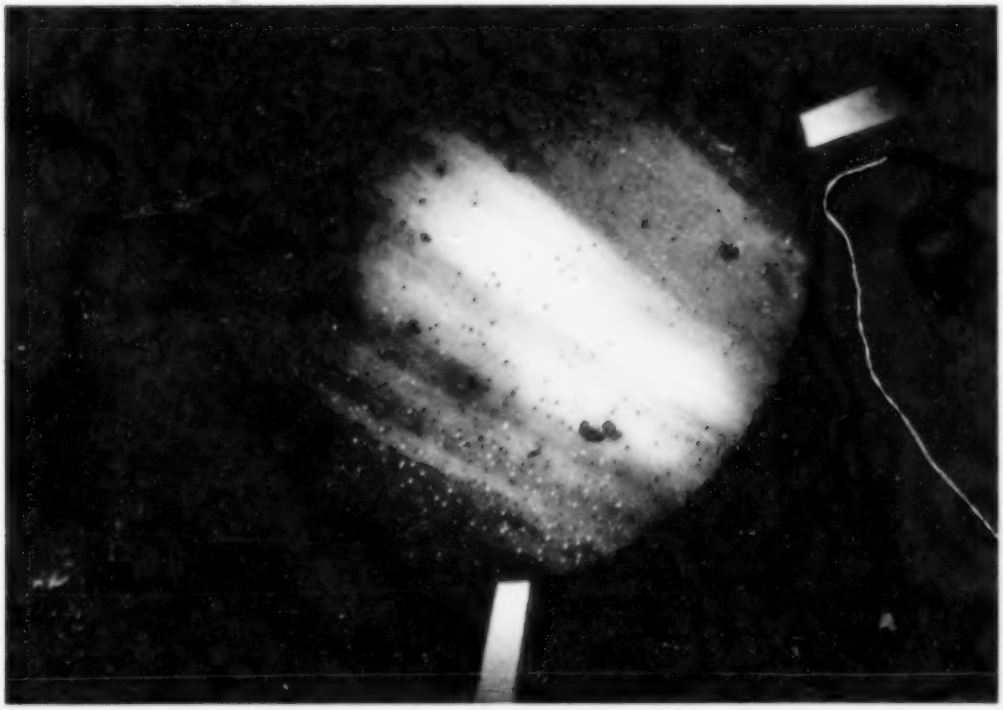


Figure 3-67. 120-MM M256 Tube
Light chrome pitting and chipping of bore.

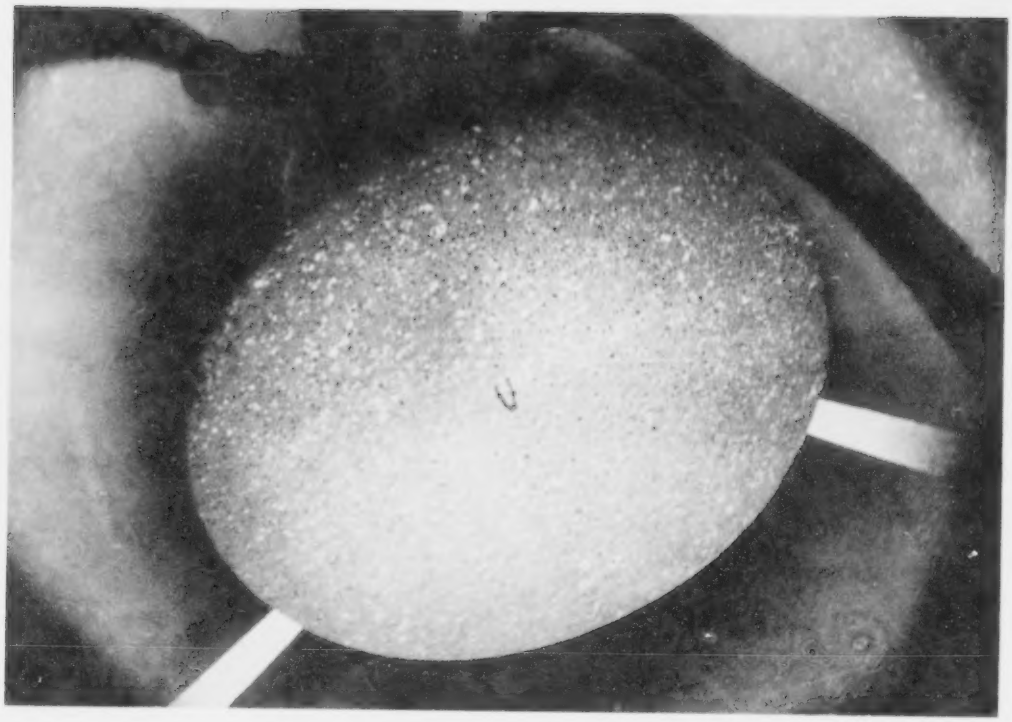


Figure 3-68. 120 MM 256 Tube
Moderate chrome chipping and pitting of bore.

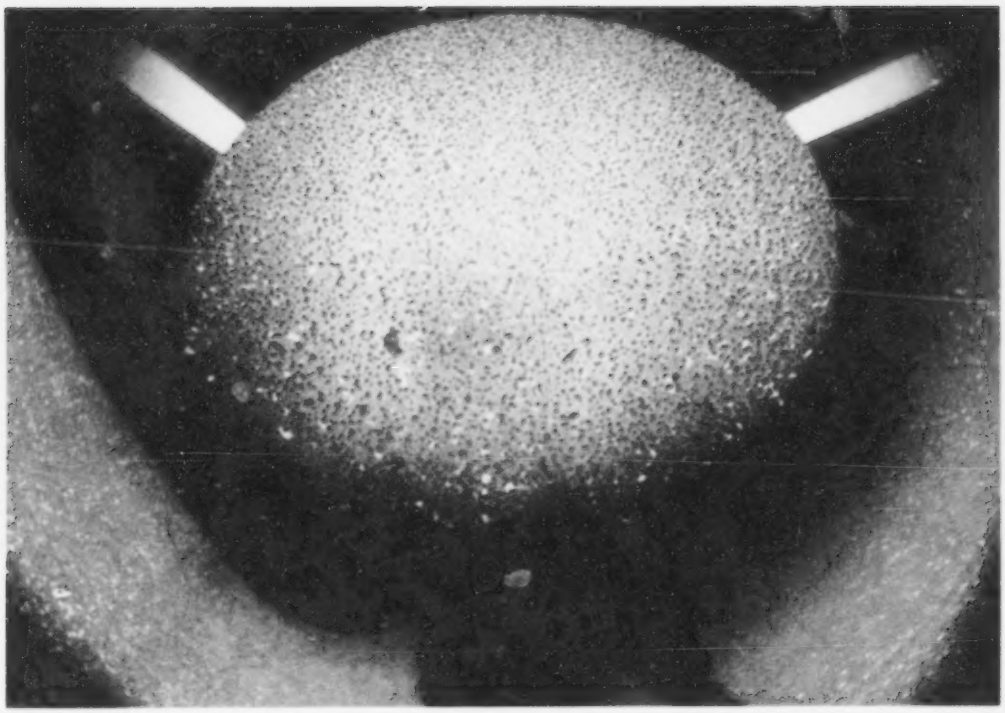


Figure 3-69. 120-MM M256 Tube
Heavy chrome pitting of bore.

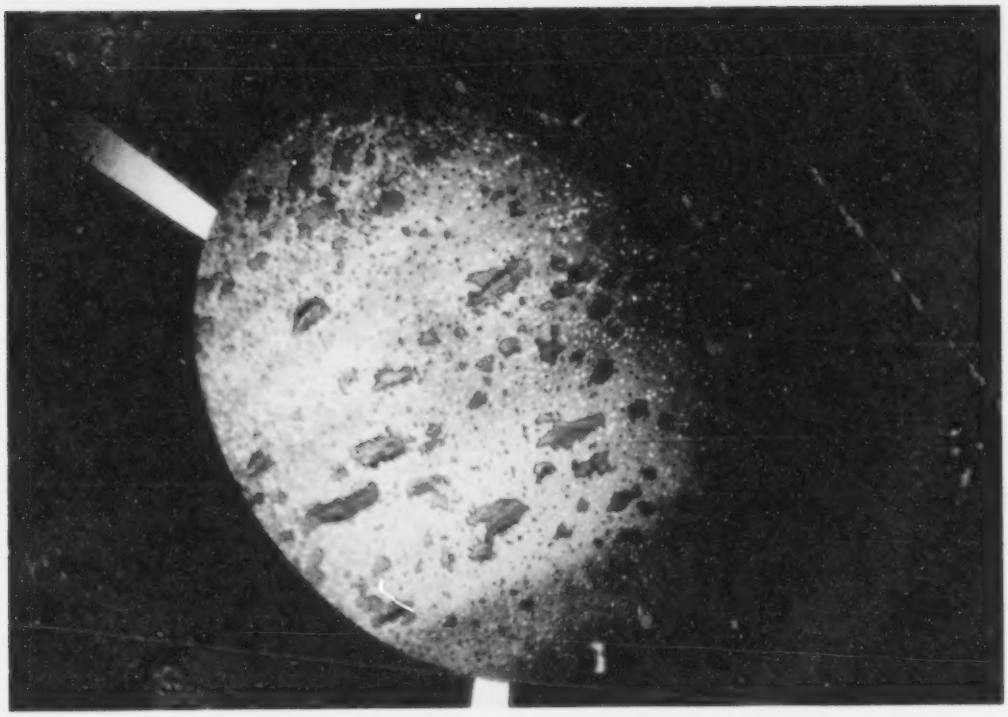


Figure 3-70. 120-MM M256 Tube
Heavy chrome chipping of bore with some light bore erosion.

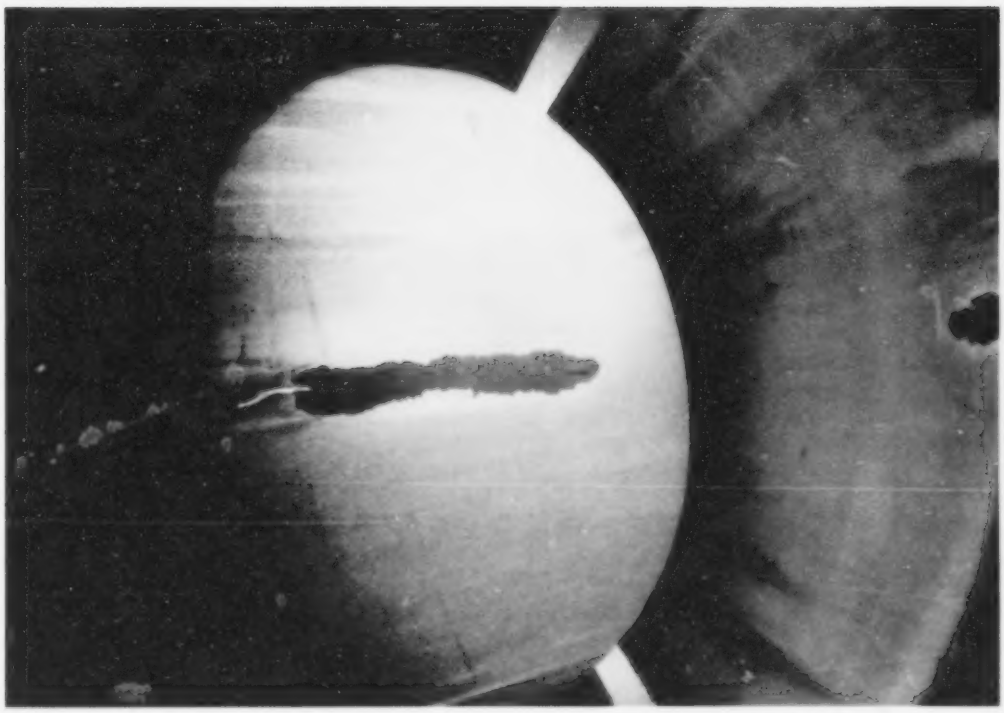


Figure 3-70.1 120-MM M256 Tube
Light chrome stripping of bore.

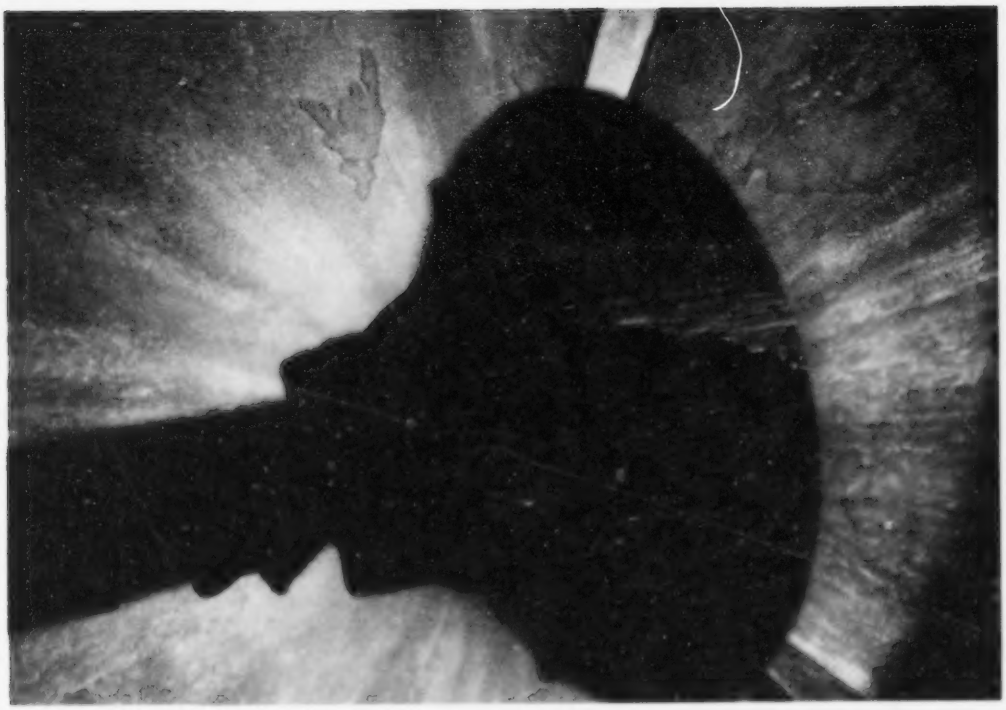


Figure 3-70.2 120-MM M256 Tube
Heavy chrome stripping of bore.

Figure 3-70.3 120-MM M256 Tube
Bore Evacuator hole erosion starting at forward edge of evacuator hole and continuing downbore.

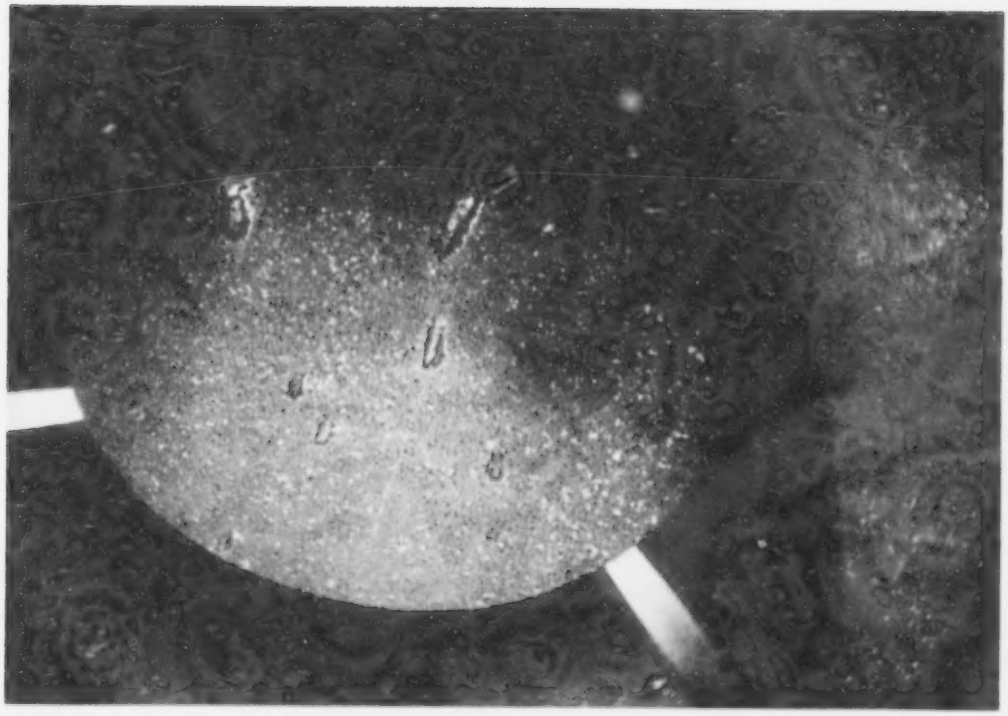


Figure 3-70.4 120-MM M256 Tube
Light Bore Erosion.

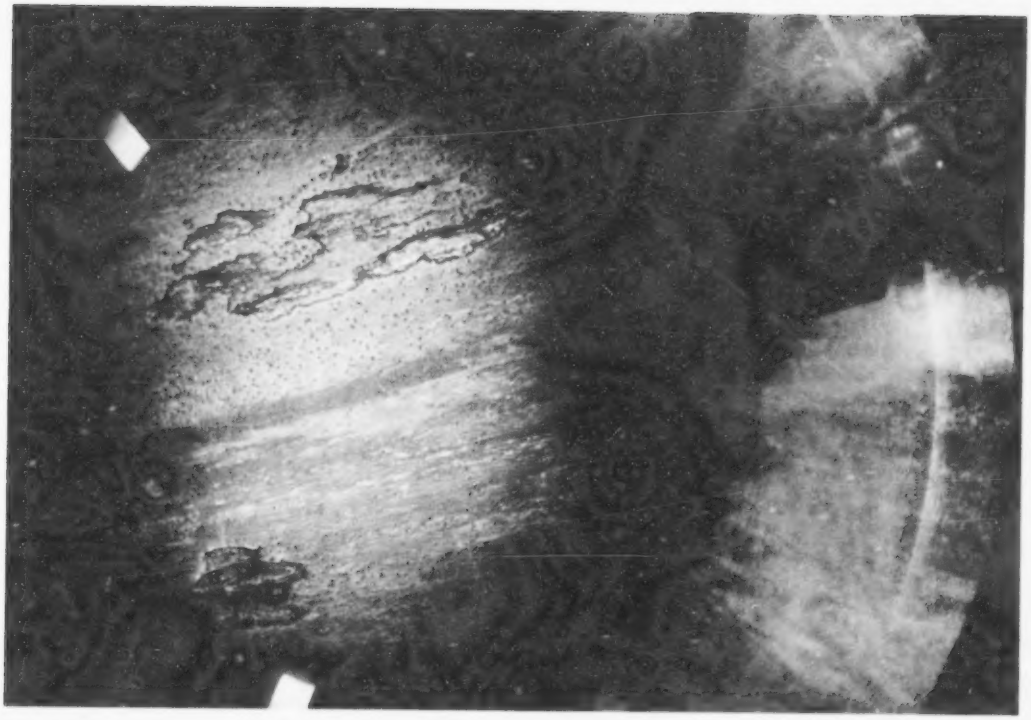


Figure 3-70.5 120-MM M256 Tube
Moderate Bore Erosion.

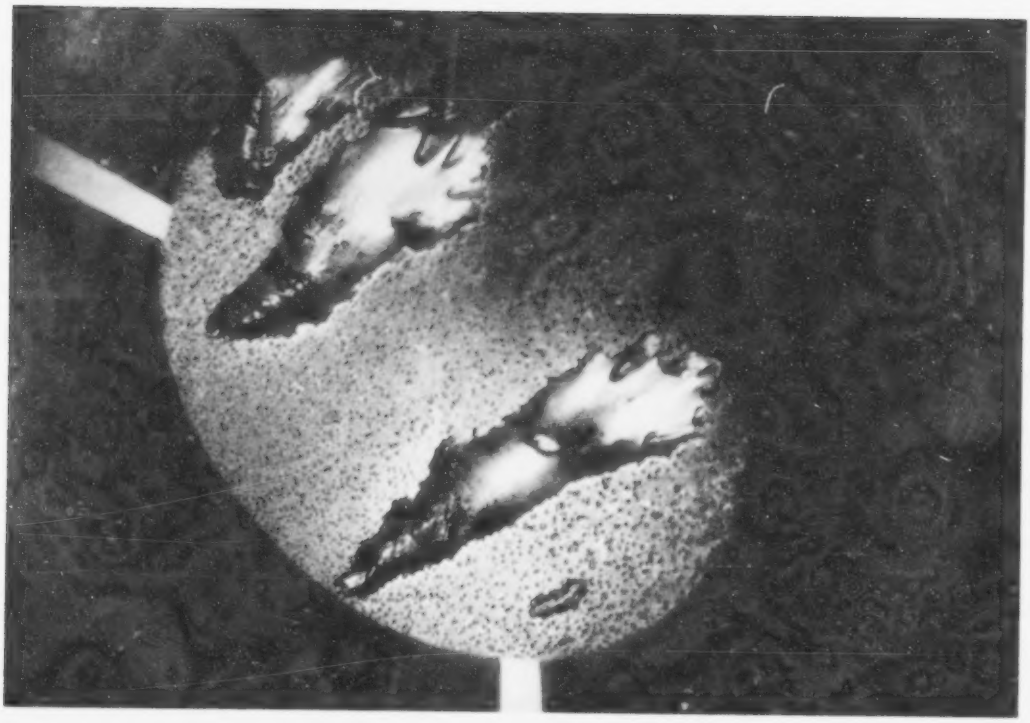


Figure 3-70.6 120-MM M256 Tube
Heavy Bore Erosion.

(3) See preceding paragraph *k* regarding gas check seat.

p. Visible Bulges, Bends, Out-Of-Roundness. Condemn tube.

q. Scoring in Chamber (fig 3-72). Condemn tube only if scoring causes extraction of case to be difficult.

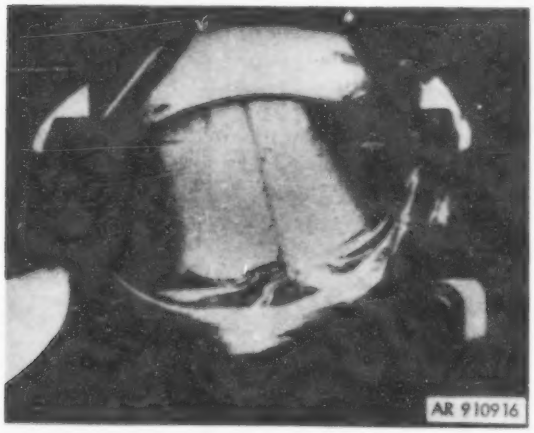


Figure 3-72. Damage to chamber caused by split case: CONDEMN.

r. Rust. Rust is not critical, but checks should be made for pitting caused by it. Rust should be removed.

s. Coppering. Copper streaks found in the bore do not affect range or accuracy and shall be ignored. Do *not* try to remove copper.

t. Bore Enlargement. Any tube which has been subjected to an in-bore premature and has not failed should be returned to a depot for inspection. Any bulge which enlarges the land and groove diameters 0.01 inch or more for a distance of one and one-half calibers or more is cause for condemnation. Bulges as large as this tend to disturb the functioning of the fuse.

u. Recoil Keyway Wear (fig 3-73). Condemn tube if recoil keyway has over 0.010-inch wear caused by key (1.010 inch maximum width).

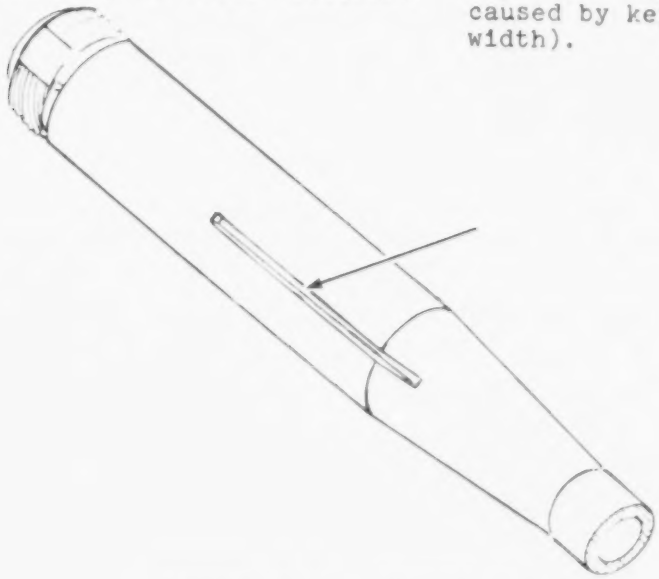


Figure 3-73. Recoil keyway on tube.

3-10. Ammo Detent Hole Damage (152-MM Gun Launchers Only)

a. When borescoping, check for cracks around hole (fig 3-74). Condemn tube if crack exceeds 1/4-inch length.

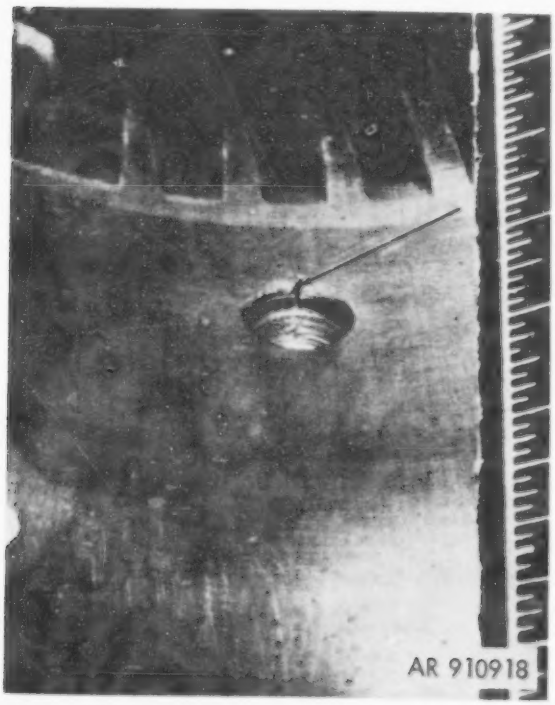


Figure 3-74. Small internal crack at ammo detent hole: ACCEPTABLE. 152-MM gun launcher.

b. When detent housing is removed, inspect as follows:

(1) Tools Needed. A Detent Inspection Kit (11578500) which contains an otoscope, mirror, cleaning tool. sanding strip, detent seal tool, surface roughness scale, caliber 0.50 powder-chamber brush, clean rags, and PL cleaner.

(2) Preliminary Preparation

(a) Vehicle M551 "Sheridan" - first remove coaxial machine gun, then spent cartridge case bag and its bracket.

(b) M60A2 Tank - jack weapon out of battery by attaching an M3 oil pump to counter-recoil buffer and pumping out of battery.

(c) Remove type 1 and 2 detent assemblies in accordance with TM 9-2350-230-35/2. Remove type 3 in accordance with TM 9-2350-232-34.

(d) Remove all carbon residue using PL cleaner. Use a caliber 0.50 powder-chamber brush to remove solid residue, and the cleaning tool with strips of clean rags inserted in slot to remove loose residue and oil.

(3) Inspection Procedure

(a) Inspect seal area of detent hole for 360°, using mirror and otoscope. See figure 3-75 for identification of seal area and for correct method of equipment use.

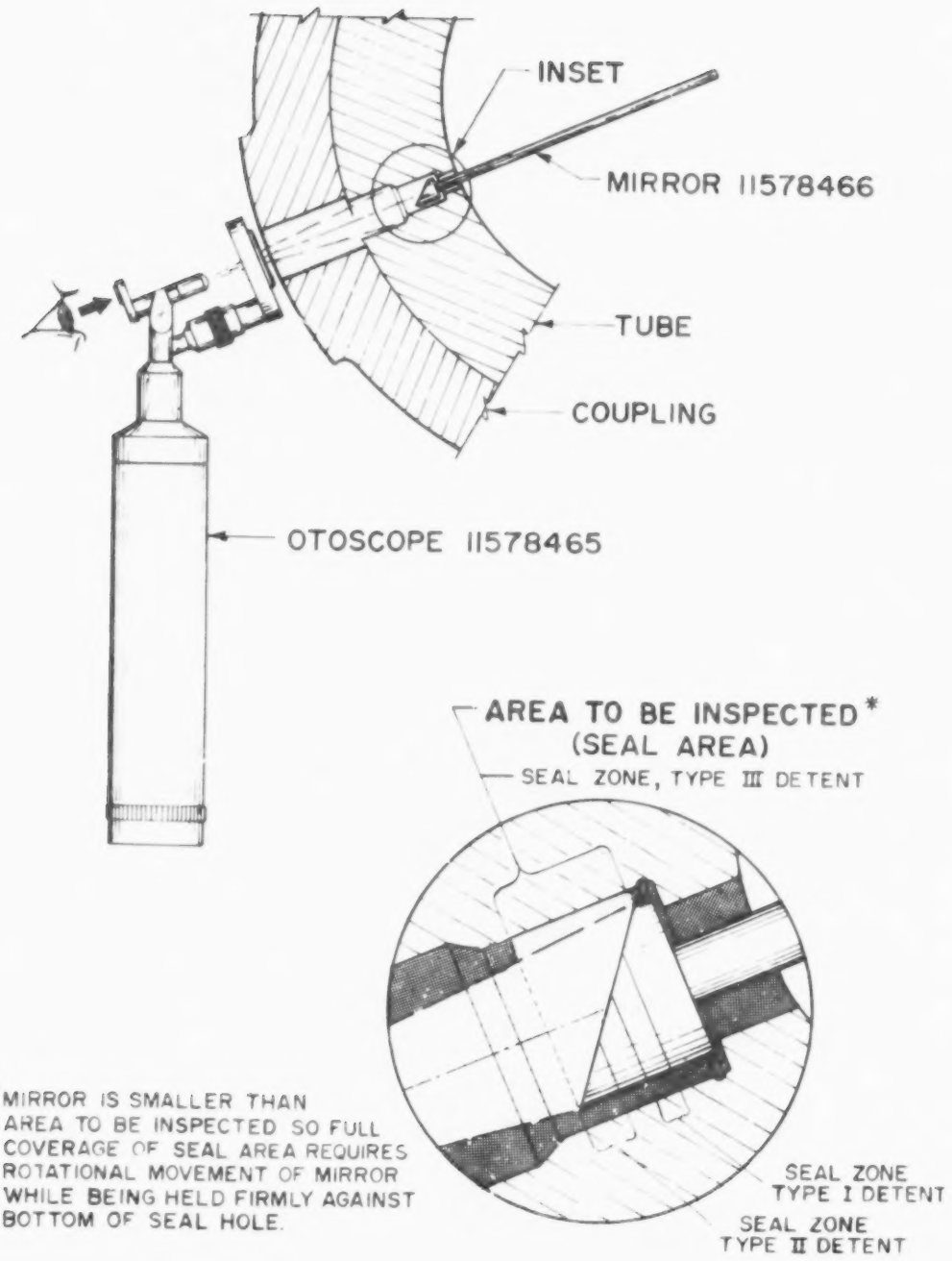

INSET
MIRROR 11578466
TUBE
COUPLING
OTOSCOPE 11578465
AREA TO BE INSPECTED*
(SEAL AREA)
SEAL ZONE, TYPE III DETENT
SEAL ZONE
TYPE I DETENT
SEAL ZONE
TYPE II DETENT
*MIRROR IS SMALLER THAN AREA TO BE INSPECTED SO FULL COVERAGE OF SEAL AREA REQUIRES ROTATIONAL MOVEMENT OF MIRROR WHILE BEING HELD FIRMLY AGAINST BOTTOM OF SEAL HOLE.
AR 910919

Figure 3-75. Position of equipment inspecting seal area.

NOTE

Hold mirror firmly against bottom of hole while rotating it.

(b) Since seals for various detent types do not all contact tube detent hole surface at same spot, hole damage may be so located that hole is acceptable for one type of detent but unacceptable for another. Scribe lines are placed in mirror to locate areas of sealing contacted by Type I and Type II preformed packing in hole. Seal boundaries, or zones, for various types of detents are as follows:

Type I detent--Area bounded by two lower scribe lines in mirror. Damage *outside* of these lines will not affect tube serviceability with type I detent.

Type II detent--Area bounded by upper scribe line and top edge of the mirror. Damage *outside* of this zone will not affect tube serviceability with type II detent.

Type III detent-Complete field of view of mirror, when held and rotated per instructions. Any damage visible in mirror will affect tube serviceability with type III detent.

(c) See cross-sectional views of typical damages in figures 3-76 through 3-82. Inspection mirror has been omitted in the cross-sectional view for clarity. Dotted lines represent seal boundaries for various detent types.

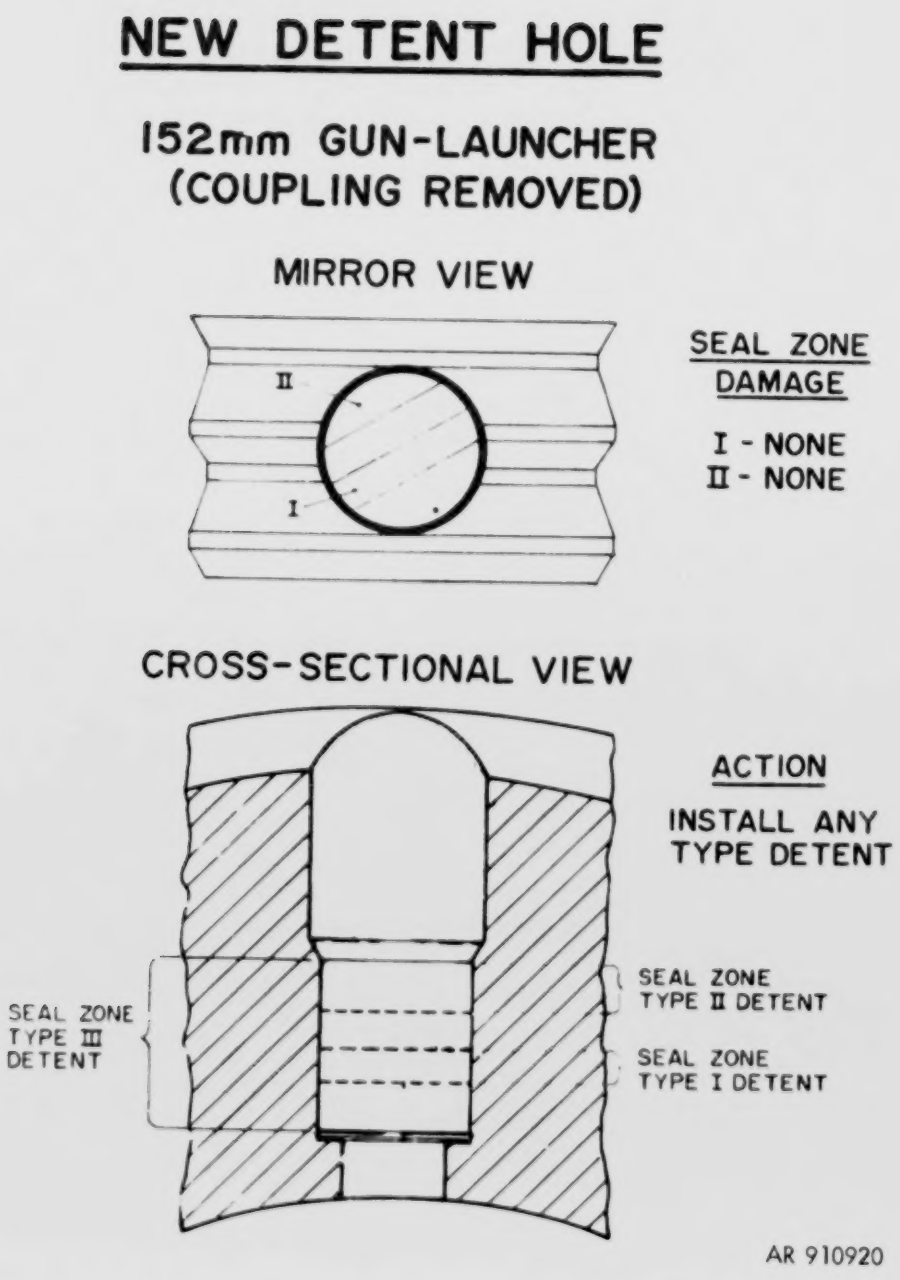


Figure 3-76. New detent hole.

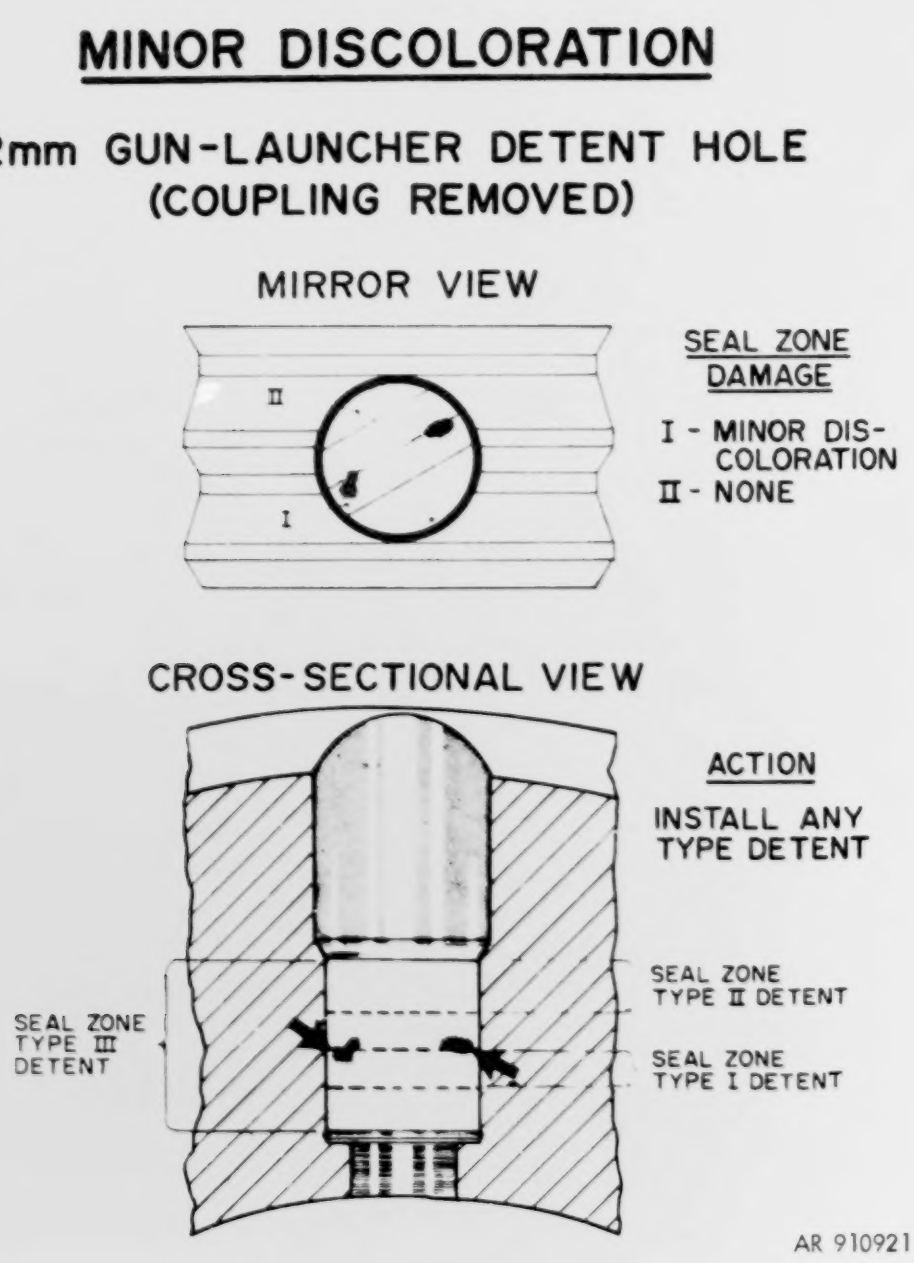


Figure 3-77. Minor discoloration.

SEVERE EROSION

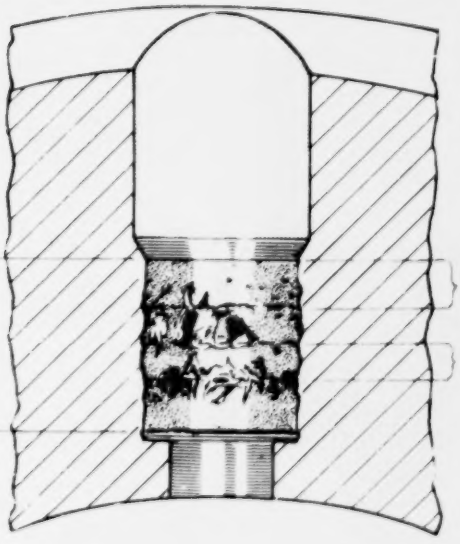
152mm GUN-LAUNCHER DETENT HOLE (COUPLING REMOVED)

MIRROR VIEW

SEAL ZONE DAMAGE

I - SEVERE EROSION
II - SEVERE EROSION

CROSS-SECTIONAL VIEW



ACTION

REJECT TUBE

SEAL ZONE TYPE III DETENT

SEAL ZONE TYPE II DETENT

SEAL ZONE TYPE I DETENT

AR 910922

Figure 3-78. Severe erosion.

SEVERE EROSION

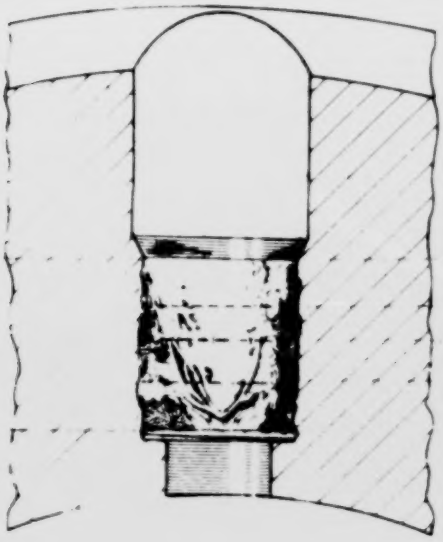
152mm GUN-LAUNCHER DETENT HOLE (COUPLING REMOVED)

MIRROR VIEW

SEAL ZONE DAMAGE

I-SEVERE EROSION
II-SEVERE EROSION

CROSS-SECTIONAL VIEW



ACTION

REJECT TUBE

SEAL ZONE TYPE III DETENT

SEAL ZONE TYPE II DETENT

SEAL ZONE TYPE I DETENT

AR 910923

Figure 3-79. Severe erosion.

CORROSION & EROSION

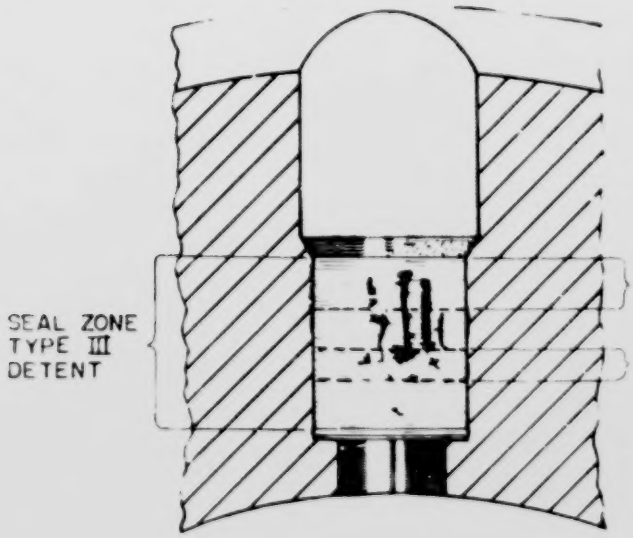
152mm GUN-LAUNCHER DETENT HOLE (COUPLING REMOVED)

MIRROR VIEW

SEAL ZONE DAMAGE

I - CORROSION AND EROSION
II - CORROSION AND EROSION

CROSS-SECTIONAL VIEW



ACTION

REJECT TUBE

AR 910924

Figure 3-80. Corrosion and erosion.

PITTING & DISCOLORATION

152mm GUN-LAUNCHER DETENT HOLE (COUPLING REMOVED)

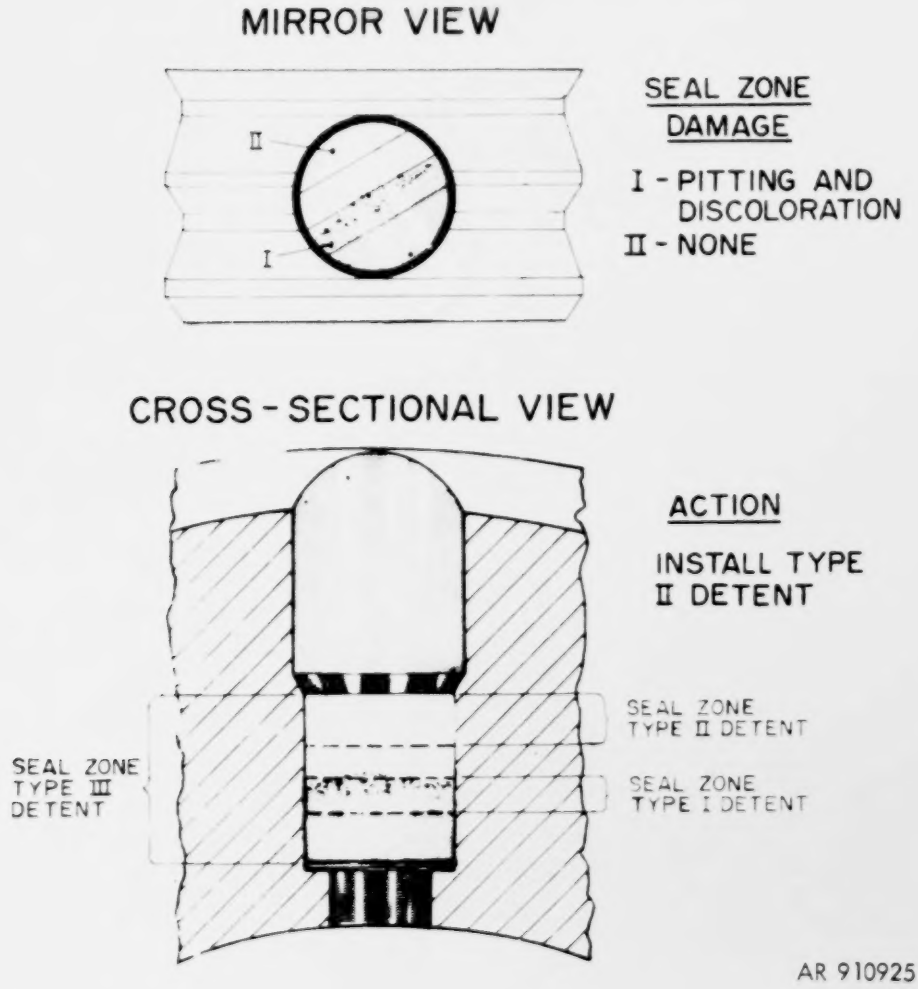
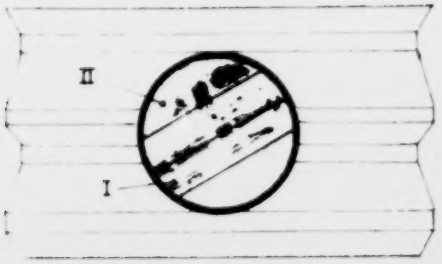


Figure 3-81. Pitting and discoloration.

PITTING & CORROSION

152mm GUN-LAUNCHER DETENT HOLE (COUPLING REMOVED)

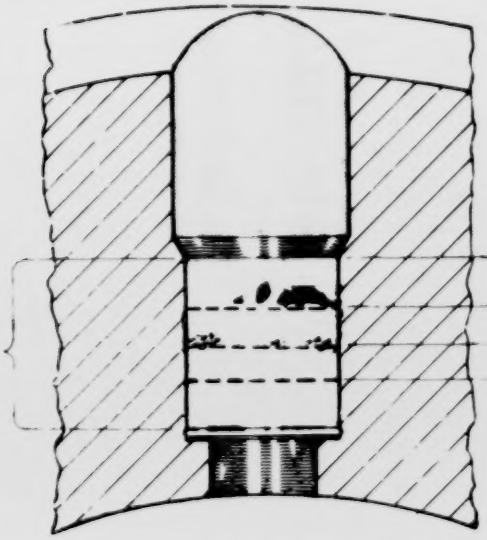
MIRROR VIEW



SEAL ZONE DAMAGE

I - NONE
II - PITTING AND CORROSION

CROSS-SECTIONAL VIEW



ACTION

INSTALL TYPE I DETENT

AR 910926

Figure 3-82. Pitting and corrosion.

(d) Since view of hole walls (using otoscope and mirror) is somewhat restricted, mirror view of each hole is also shown to provide a correlation between the condition and its mirror view.

NOTE

Coupling removal is not a requirement for satisfactory examination of detent hole. Illustrations show coupling removed only for reasons of clarity.

NOTE

One inspector should hold and rotate mirror while the other inspects.

(4) Acceptance Criteria.

(a) Acceptable. For *any* type of detent (I, II, or III), if surface of sealing area of detent hole (fig 3-76) is smooth and bright, with no evidence of pits, corrosion, or scratches. Dark staining (discoloration) of surface is acceptable provided a surface finish of 32 or better is maintained. For a valid comparison of surface finish, view both hole and roughness scale through the otoscope. Figures 3-76 and 3-77 show typical acceptance detent holes. Note that seal zones for each type of detent are bounded by dashed lines in a cross-sectional view. Figure 3-76 is a new tube and detent hole. Figure 3-77 is a used tube and detent hole after cleanup. This hole cleaned up almost 100%. Minor discoloration shows up in two areas (see arrows).

NOTE

If an M81E1 or M162 tube is replaced because detent hole criteria show it to be unacceptable, but there is at least 400 rounds life remaining, send it to depot for reclamation.

(b) Unacceptable. Detent holes are unacceptable if eroded, corroded, or pitted sufficiently over seal surface to show visible roughness or corrosion. Erosion occurs mostly at 6 o'clock and 12 o'clock positions of detent hole (clock positions facing detent hole in cannon, where 9 o'clock is towards muzzle). Figures 3-78 and 3-79 show typical detent holes which have been badly eroded over *whole* seal area due to seal failure. Tubes should be condemned because refurbishment of such holes is *not* practical. Figure 3-80 is an example of a detent hole which has suffered relatively minor erosion and corrosion. Damage to this hole, while not as severe as that of figures 3-78 and 3-79, is still extensive enough to render tube unserviceable for conventional round firing. Since damage is present in all seal zones, sealing against gas pressure will not be effective, no matter which type of detent is installed. Figures 3-81 and 3-82 are additional examples of slightly pitted and/or corroded detent holes. Such damage, if present in seal zones for both Type I and Type II detents, would make tube unacceptable.

(c) Conditionally Acceptable. Detent holes may be classified as conditionally acceptable for Type I detent only or Type II detent only when erosion or corrosion appears in only one area of detent hole. That is, when damage may show on sealing surface contacted by a Type I detent preformed packing but still be perfectly acceptable in area of the Type II detent seal. When assigning a "conditionally acceptable" classification to a detent hole, detent type

to be used must also be specified (the only type usable is one which utilizes the undamaged seal zone). Figure 3-81 shows fairly extensive discoloration (which is not grounds for rejection) and some pitting in area of a Type I detent seal (seal zone 1). Since damage does not extend into seal zone II, tube is still serviceable with a Type II detent installed.

NOTE

Seal zone III encompasses both seal zones I and II, so the Type III detent cannot be used.

Detent hole in figure 3-82 shows evidence of both pitting and corrosion in seal zone II and between seal zones I and II. Seal zone I, however, is still undamaged, so the tube is still serviceable with a Type I detent installed.

(d) Questionable. If you doubt acceptability of a detent hole, refurbish it by manually polishing hole seal surface, using a cleaning tool and sanding strip (fig 3-83), until corroded or pitted areas have been removed. Do *not* use power operation (high RPM), as it has a tendency to produce elliptical holes.

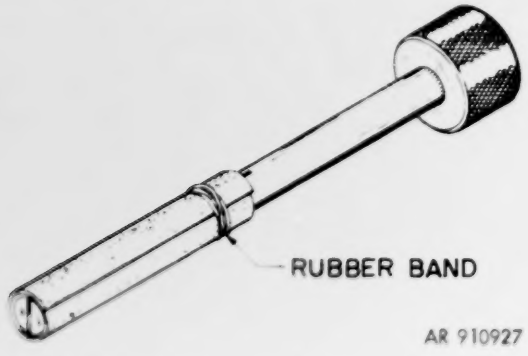


Figure 3-83. Cleaning tool.

CAUTION

Sanding strips are silicon carbide, 180 grit, MOC965F or Norton 150-J closekote aluminum oxide. No material having a coarser grit shall be used.

3-11. Obturator Seat and Cavity Damage (152-MM Gun Launchers Only)

a. Clean and polish seal seat as follows:

(1) Thoroughly clean seat and cavity with PL bore cleaner and a soft brush.

(2) Manually polish seal seating surface. Do not use any abrasive. Remove any accumulation of crud, rust, and stains.

b. Carefully examine entire seating surface, using otoscope furnished with a 152-MM tube detent hole inspection kit.

c. Send tube to depot for overhaul if present obturator seal, or a new replacement, won't stay snapped in place.

d. If erosion, corrosion, pitting, gouges or galling, regardless of depth, cross more than 30% of the seat in the axial "W" direction (fig 3-84); send tube to depot for overhaul.

e. If a scratch extends full length of seat "W" running axially at an angle or spiral, send tube to depot for overhaul.

f. If seat has any raised or upset metal, regardless of depth, send tube to depot for overhaul.

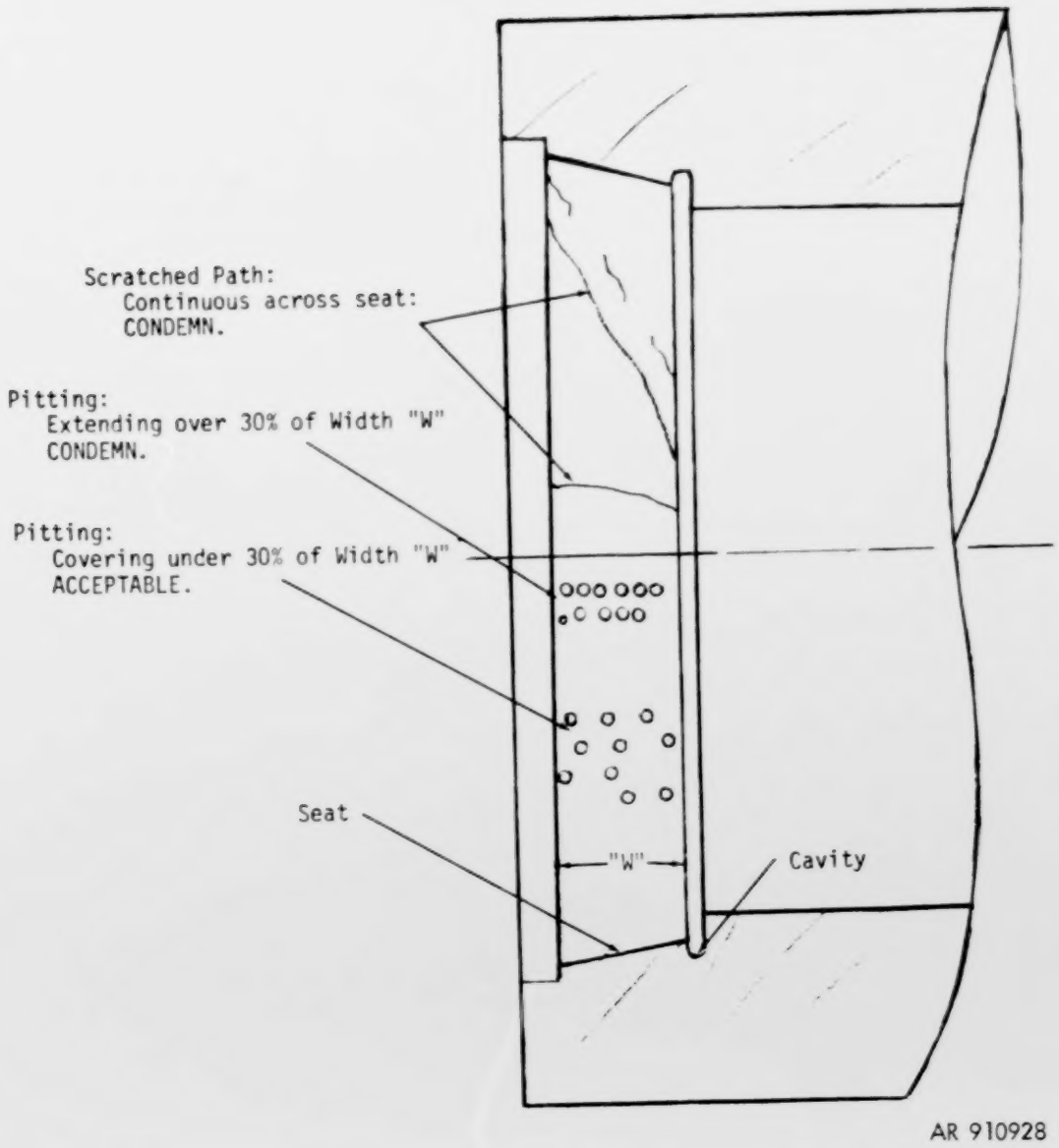


Figure 3-84. Pitting and scratches on obturator seat: 152-MM gun launcher.

3-12. Scavenger Hole Damage (152-MM Gun Launchers Only)

a. Valve seal surface at hole on tube (this is the smooth, raised circular area).

(1) Clean surface using bore cleaner, and wipe with clean dry cloth.

(2) Inspect surface using flashlight or otoscope furnished with detent hole kit.

(3) Send tube to depot for overhaul if you find erosion path, scratch, gouge or continuous rust pits (regardless of depth) which extend *completely* across the surface (fig 3-85).

b. Internal Hole: Cracks are acceptable (fig 3-86).

c. In M162 tube, these holes are located in the breech coupling and breechblock. See specific TM for inspection of these tubes.

3-13. Bore Evacuator Hole Damage (Internal) (152-MM Gun Launchers Only)

Condemn tube if damage on edge of hole cuts into groove between lands (figs 3-87 through 3-89).

Figure 3-85. Erosion from scavenger hole: CONDEMN. 152-MM gun launcher.

Figure 3-86. Internal cracks on scavenger hole: ACCEPTABLE. 152-MM gun launcher. (fig 3-87, 3-88 and 3-89).

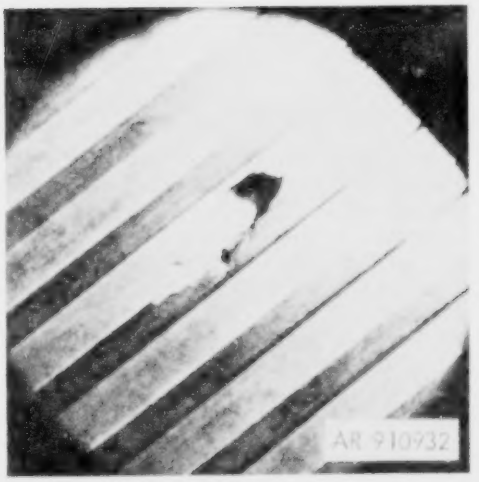


Figure 3-88. Evacuator hole damage: CONDEMN. 152-MM gun launcher.

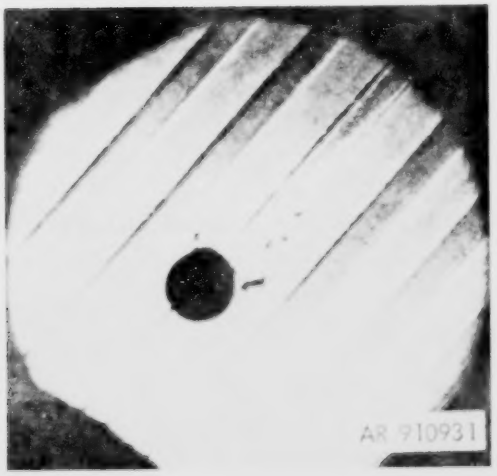


Figure 3-87. Evacuator hole damage: CONDEMN. 152-MM gun launcher.

Figure 3-89. Evacuator hole erosion: ACCEPTABLE. 152-MM gun launcher.

Section III. MORTARS

3-14. Special Frequency of Inspection

a. 60-MM Mortar. Borescope and pullover gage after every 1,000 rounds, once 10,000 rounds are reached, or after bore diameter reaches 2.402-inches. Borescope every 100 rounds when firing 22 subcaliber sabot training rounds. When firing records are missing or you think them inaccurate, and if your borescope finds no evidence of erosion rings, begin round count at 10,000.

b. 81-MM Mortar. In addition to frequencies given in paragraph 3-3, borescope and pullover gage after every 500 rounds once 5,000 rounds are reached. Pullover gage and make an impression measurement (para 3-17) after every 500 rounds when erosion rings first appear. When firing records are missing or you think them inaccurate, if your borescope finds no evidence of erosion rings, begin round count at 4,000. If you see the rings, begin round count at 5,000. Borescope every 100 rounds when firing 22 subcaliber sabot training rounds.

c. 4.2-Inch Mortar. Borescope and pullover gage after every 500 rounds once 4,000 rounds are reached.

3-15. Short Rounds

WARNING

Short rounds of the M2A1, M2A1 (ALT), M328, and M329 may be caused by firing these rounds with less than 7 increments. Short rounds of the M328A1 and M329A1 may be caused by firing with less than 10 increments.

If occurring after 5,000 rounds, condemn tube.

3-16. Wear Limits

a. Condemn tube if it is over diameter limits (via pullover gage) listed in table 3-8.

b. Take multiple readings at unspecified locations throughout length of tube. A reading at any location in excess of condemning limit diameter will be cause for condemnation.

Table 3-8. Condemning Limits for Mortar Cannon Tubes

Caliber	Model no.	Basic bore diameter	Pullover gage used	Condemning limit diameter
60-MM	M2, M19, M224	2.392	57-MM	2.411
81-MM	M29, M29A1, M252	3.205	76-MM	3.227
4.2-Inch	M30 (T104)	*4.200	105-MM	*4.221

*Land diameter

c. Take readings in actual bore diameters rather than amount of erosion taken from vernier on pullover gage. Take reading with the vernier caliber (normally used to calibrate gage).

d. Condemn 60-MM and 81-MM mortar tubes when erosion exceeds 0.125 at any point around firing pin. Note that the basecap can be replaced on the lightweight 60-MM, M225.

3-17. Inspect for Damages

a. Use a borescope in all tubes.

CAUTION

DO NOT remove basecaps or allow them to become loosened. The exception is the M19 Mortar which has its cap removed for maintenance and service.

b. For following damages, condemn both tube and basecap:

(1) Loose basecap or evidence of gas leakage between tube and basecap of 81-MM mortar. An M19 Mortar with a loose cap may be retightened if there is no damage to basecap or tube. If 4.2-inch, send cannon to depot for overhaul. The 81-MM M252 does not have a basecap; however, paragraph 3-17b(5) applies for damage and condemnation.

NOTE

The firing mechanism of 60-MM Mortar, M19, may be reused.

(2) Cracks on tube or basecap; on the M225 cannon, a cooling fin that is cracked or has a segment broken off.

(3) Visible bulges or enlarging bore over 0.010-inch.

(4) Dents, out-of-roundness, or internal damage which prevent a dummy round from dropping freely.

(5) Internal pits or scores larger than 3/8-inch or over 0.010-inch deep. (fig 3-89.1) Check any aluminum colored streaks for 0.010-inch depth (fig 2-31).

Figure 3-89.1. Internal pits and scores: ACCEPTABLE. M224 60mm Mortar.

Figure 3-90. Lands mushroomed and split: CONDEMN. 4.2-inch mortar.

Figure 3-91. Severely flattened lands: CONDEMN. 4.2-inch mortar.

(6) One or more missing lands. (For other damages to lands, see fig 3-90 and 3-91 to determine how critical they are).

(7) Bent basecap or immoveable firing pin.

(8) Broken or missing section of a cooling fin.

NOTE

Small nicks or gouges in the top of the cooling fins are acceptable.

c. Remove upset metal from shallow scores or dents on top of lands (fig 3-92) or on the bores of smoothbore tubes.

d. Erosion rings in 81-MM mortar (fig 2-29)--Use borescope to look for erosion rings near breech end.

These are caused by using fin M170 on ammo M374 and M375, and they do not appear until after 4,000 rounds. You can't measure ring depth with pullover gage, so make impression measurement as follows (repeat every 500 rounds):

(1) Clean mortar tube, wipe dry, and take a pullover gage reading.

NOTE

Pullover gage reading should be taken one half inch in front of first ring toward muzzle end of tube.

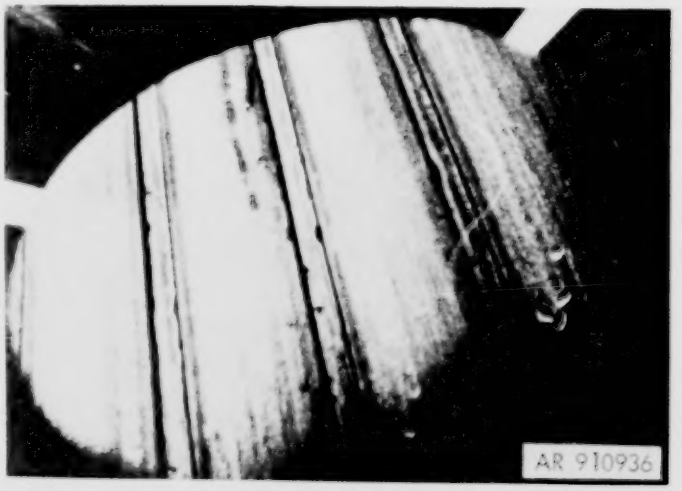


Figure 3-92. Minor dents: ACCEPTABLE. 4.2-inch mortar.

(2) Position mortar tube horizontally, with muzzle end blocked up approximately 1-inch higher than breech end.

(3) Insert a casting stop (wood plug - 3.200-inches in diameter and 4-1/2-inches long) into tube until it rests against firing pin.

(4) Mix approximately 6 ounces of VEL-MIX-STONE (table 3-1), four parts of powder to one part of water, to consistency of thick paint. Stir mix for one minute.

NOTE

Add STONE to the water.

(5) Make a pouring container by wedging a small can or paper cup (2-inches in diameter and 2-inches deep) between prongs of cleaning staff M8. Insert staff with a cup of stone mixture all the way into mortar tube to casting stop. Raise staff and cup to top wall of the mortar and rotate staff 180°, allowing stone mixture to pour from cup.

(6) Withdraw staff and cup; allow casting to harden. Hardening time is normally 30 to 45 minutes. A mixture with more water takes longer to harden. Use remaining stone mixture to check hardening time.

(7) When mixture has hardened, rotate the tube. Casting will release and slide out of muzzle. Impression casting is fairly strong but will not withstand dropping or rough handling. If casting stop will not slide out of tube, it can be removed by inserting a 1/8-inch diameter wire through firing pin hole.

(8) Tube damage will appear as ridges on impression cast. Due to shape of cartridge fin assembly, highest ridge will be one nearest to muzzle end of casting.

(9) Using thickness gage and steel rule, measure height of ridge as shown in figure 3-93. When measuring, take care to keep the thickness gage flat on the casting and the rule parallel with both the thickness gage and the forward end of the casting surface.

(10) Determine ridge height in thousandths of an inch. Double this and add it to pullover gage reading (para 3-17*d (a)*). If sum equals or exceeds 3.227-inches, mortar tube must be condemned.

EXAMPLE"

Impression measurement	0.005 x 2	inch
	0.010	inch
Pullover gage reading	+3.220	
Total	3.230	inches--condemn the tube

(11) If the mortar tube is not condemned, carefully remove all of residue left in tube.

(12) Enter the number of rounds and the impression measurement of the casting in REMARKS column of DA Form 2408-4.

e. Impinge brass fragments will occur when firing M70 and M888 HE 60mm ammo at successive charges of one or less (see fig 3-92.1). It should be recognized that the borescope image is magnified by 2.2x and will tend to exaggerate any indentations or brass fragments in the bore. Only by taking a cast as described in preceeding paragraph 3-17d(1) through 3-17d(12) can the actual size of these fragments be determined.

Figure 3-92.1. Brass impingement: Acceptable. M224 60mm Mortar.

f. Erosion around firing pins of 60-MM and 81-MM mortars in excess of 0.125 inch in depth shall be condemned. This erosion is caused by the ejection propellant blast from the 22 subcaliber sabot training round. The following procedure shall be used to determine depth of erosion around the firing pin:

(1) Clean mortar tube and position it in the vertical position with firing pin installed.

(2) Cut a piece of 2-inch id (approx) aluminum tubing (table 3-1) 6 inches longer than the mortar tube. Make sure that ends are cut square.

(3) Mix approximately 6 ounces of VEL-MIX-STONE (table 3-1), four parts of powder to one part of water, to consistency of thick paint. Stir mix for one minute.

NOTE
Add STONE to the water.

(4) With aluminum tubing placed in mortar tube and centered around the firing pin, pour the STONE mix in and allow the STONE casting to harden (30 to 45 minutes).

(5) Withdraw aluminum tubing, remove casting, and measure the depth of erosion with a standard height gage.

(6) Erosion of 0.125 inch or more is cause for condemnation. The 60-MM cannon, M225 shall be returned to depot for replacement of basecap. The 81-MM mortars shall be demilitarized per regulations.

NOTE
Inspection for erosion shall be made after each firing of one hundred 22 subcaliber sabot training rounds. There is approximately 0.035 inch of erosion for each 100 rounds fired.

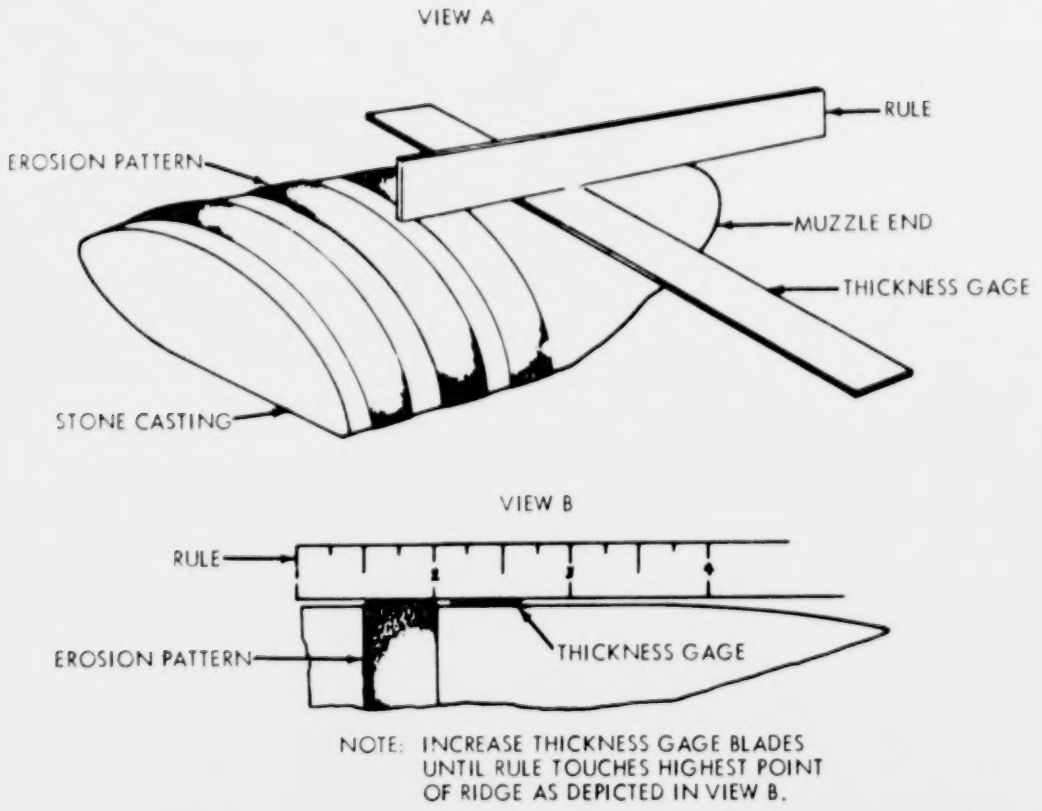


Figure 3-93. Measurement of erosion rings: 81-MM mortar.

(7) Scoring or pitting of chamber and of tube (the grooves in rifled tubes) over 3/8-inch long and over 0.010-inch deep.

(8) Additional criteria for 90-MM Recoilless Rifle, M67.

(a) Condemn breechblock if both the hammer bushing and its replacement fall out of its breechblock hole, or if cracks around hole are over 1/4-inch deep (fig 2-34).

(b) Condemn tube if pullover gage shows out-of-roundness or bore of over 0.010-inch at any location. Take readings 1-inch from muzzle and 90 degrees apart, and also at two other unspecified locations.

(c) Condemn tube if there are cracked or badly worn interrupted threads on breech end.

(d) If firing record is missing (or suspected of being incorrect) and there is no dash number on breechblock (fig 3-96) measure breechblock erosion, using radius gage in vent (fig 3-1, 3-97 and 3-98), and find from table 3-10 the estimated remaining life for both the tube and the breechblock.

(e) If firing record is missing (or suspected of being incorrect), but there is a dash number on breechblock, measure according to preceding paragraph (d). Write to Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000 for record of rounds fired through original breechblock. When available, subtract these rounds from the estimated remaining life found on table 3-9 to get remaining life for tube. Tube shall not fire over 2,000 rounds.

(9) Additional criteria for 106-MM Recoilless Rifle, M40 Series.

(a) If spotting gun support brackets are misaligned or badly damaged, send rifle and records to depot.

(b) If you find evidence of gas leakage at chamber-tube joint (fig 2-36) or past the plugged hole (fig 2-36) for round indicator, send rifle and records to depot.

(c) If tube-to-chamber is misaligned to the loosening side (chamber mark is to left of tube mark when viewed from breech) (fig 2-37), ship rifle and equipment log book to depot. If tube-to-chamber is misaligned to the tightening side more than 7/16-inch (10 degrees), ship as above.

3-20. Attached Parts

When you condemn a tube with its vent and breechblock, remove serviceable parts for use on another tube after inspection according to weapon's DS-GS technical manual.

3-21. Incomplete Weapons Records

If rounds-fired record is incomplete and the condemnation criteria given in paragraph 3-19 have not been reached, withdraw weapon from service. Send copies of incomplete records to Benet Weapons Laboratory, ATTN: SMCAR-CCB-DP, Watervliet Arsenal, Watervliet, NY 12189-5000 for evaluation and decision.

Irregular

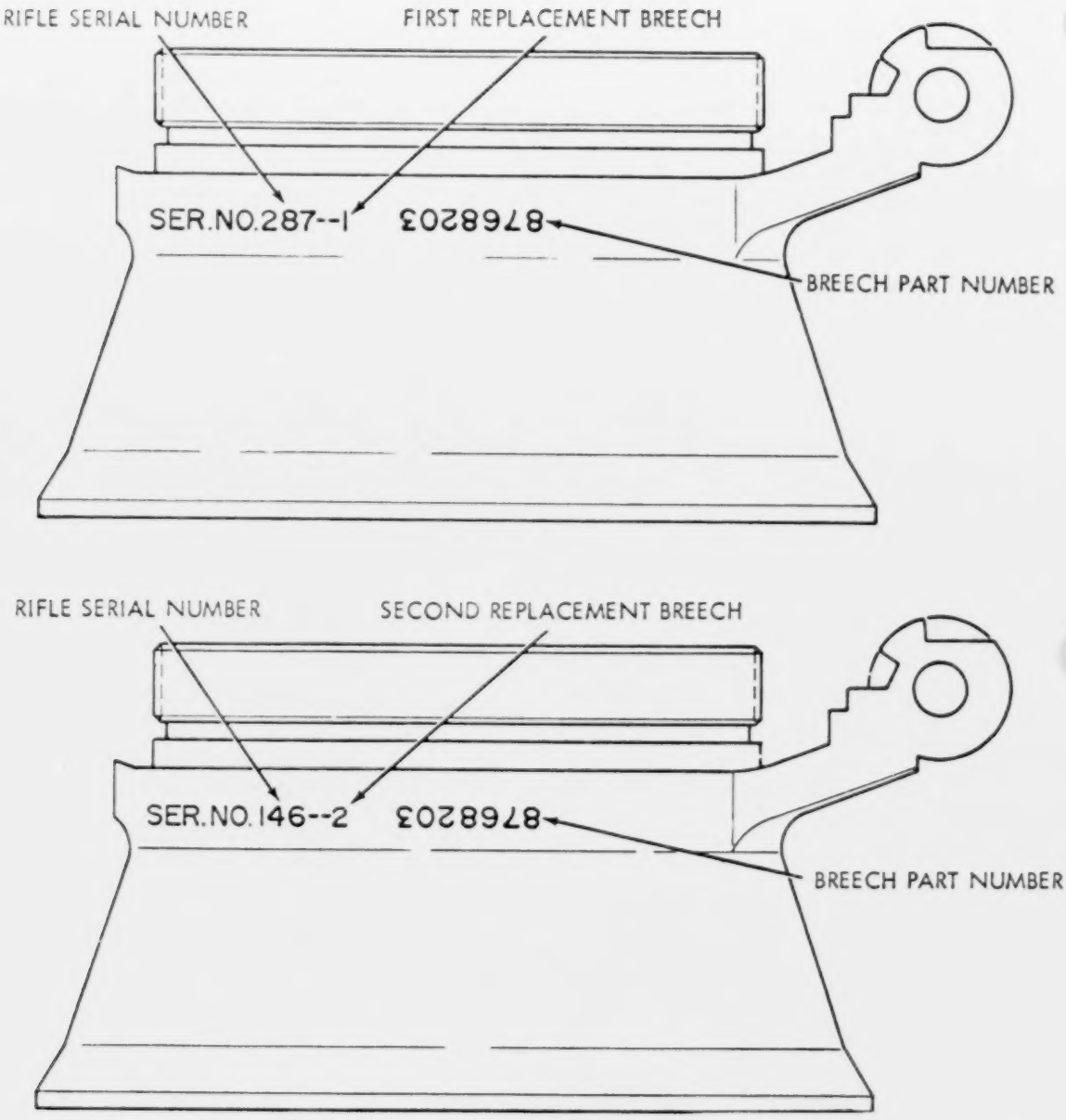


Figure 3-96. Identification of replacement breechblock: 90-MM recoilless rifle, M67.

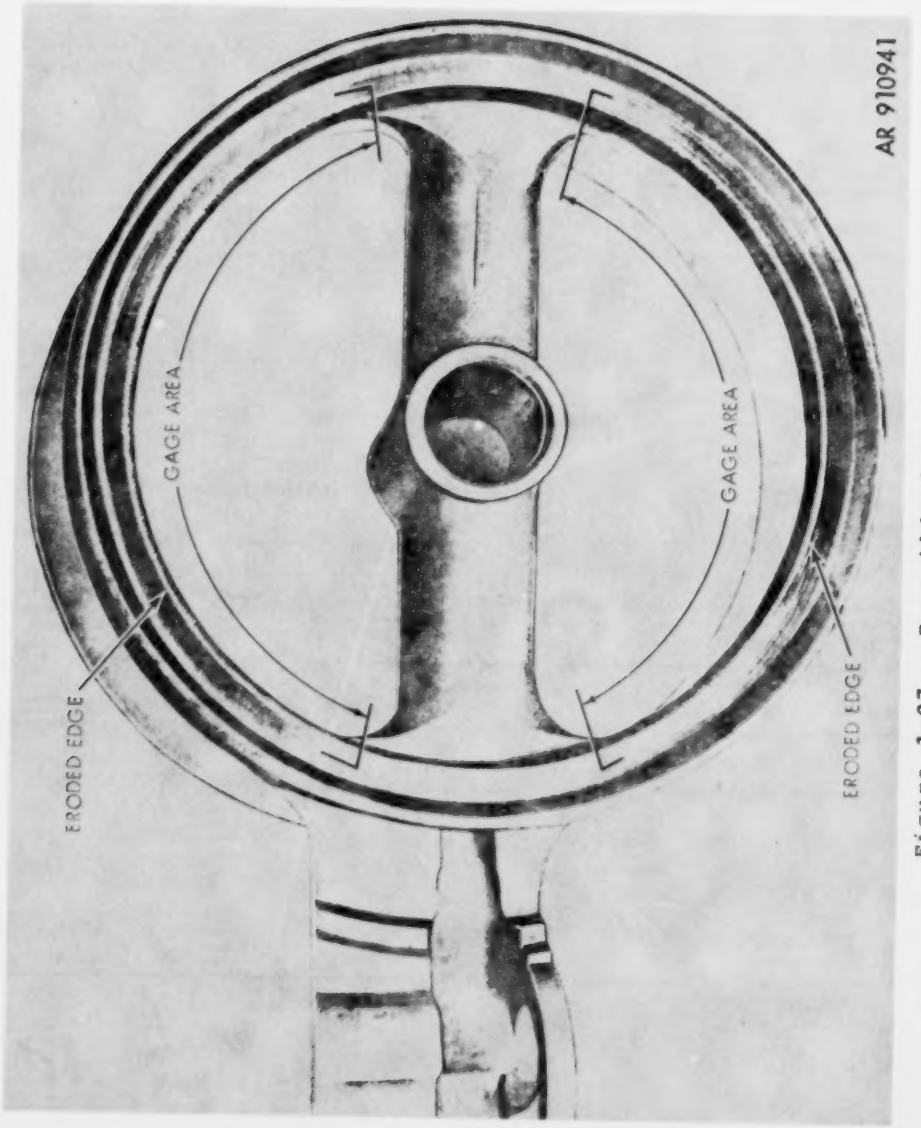


Figure 3-97. Breechblock gage area: 90-MM recoilless rifle, M67.

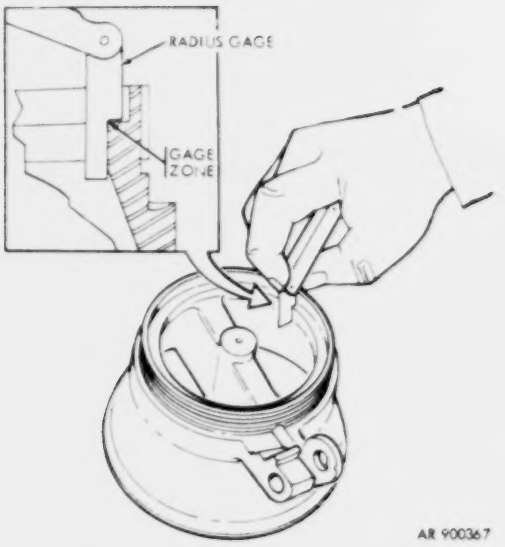


Figure 3-98. Gaging breechblock erosion: 90-MM recoilless rifle, M67.

Table 3-10. Estimated Remaining Life of 90-MM Recoilless Rifle, M67

Edge of radius of breechblock	Estimated remaining round life
0.001 to 0.020-inch	1500 Rounds
0.021 to 0.030-inch	1000 Rounds
0.031 to 0.040-inch	500 Rounds
0.041-inch and over	0

CHAPTER 4
LOW INVENTORY WEAPONS

Refer to tables 4-1 and 4-2 for life criteria. See chapters 2 and 3 for inspection instructions and damage criteria.

Table 4-1. List of Tubes Condemnable on the Basis of Rounds Fired

Caliber	Tube model no.	Use table no.
105-MM Howitzer	M2A1, M137	4-6
8-Inch Howitzer	M2	4-3
105-MM Recoilless Rifle	M27, M27A1	4-4

Table 4-2. List of Tubes Condemnable on the Basis of Erosion

Caliber	Tube model no.	Use table no.
40-MM Gun	M1, M1A1	3-2
76-MM Gun	M32	4-5, 4-5.1
155-MM Gun	M2A1	3-6
81-MM Mortar	M1	3-8
4.2-Inch Mortar	M2	3-8

Table 4-3. Life of the 8-Inch Howitzer Cannon, M2 Tube Based on EFC Round Count

Major Item	Tube model	EFC round life of tube	EFC factors	Breech life
8" Howitzer M115	M2	4,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	No retubing

Table 4-4. Condemning Limits for the Tube and Breechblock of a Recoilless Rifle

Caliber	Model no.	Condemnation round life	Additional condemning limits
105-MM	M27, M27A1	2,000	Inability to balance with 4th vent bushing. Four bushings are the limit.

All rounds have an EFC factor of 1.0.

Balance weapon by adjusting or replacing nozzle (vent) per instructions.

Table 4-5. Estimated Remaining Life of the Tube of the 76-MM Gun Cannon, M32 (T91E3) For: Tank, Combat, FT, M41A3 Estimated Tube Life Based on Bore Measurement

Bore measurement 24.75-inches forward of breech face		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.000	3.000	100	350
0.009	3.009	95	333
0.017	3.017	90	315
0.024	3.024	85	298
0.030	3.030	80	280
0.036	3.036	75	263
0.042	3.042	70	245
0.047	3.047	65	228
0.052	3.052	60	210
0.057	3.057	55	193
0.062	3.062	50	175
0.067	3.067	45	158

Table 4-5. Estimated Remaining Life of the Tube of the 76-MM Gun Cannon, M32 (T91E3) For: Tank, Combat, FT, M41A3 Estimated Tube Life Based on Bore Measurement--Continued

Bore measurement 24.75-inches forward of breech face		Estimated remaining life	
Wear (gage reading)	Actual diameter	Percentage	EFC round
0.071	3.071	40	140
0.075	3.075	35	123
0.079	3.079	30	105
0.083	3.083	25	88
0.087	3.087	20	70
0.090	3.090	15	53
0.094	3.094	10	35
0.097	3.097	05	18
*0.100	*3.100	00	00

*Condemnation Limit--Condemnation will be based on tube wear and not on rounds fired.

Table 4-5.1. Estimated Remaining LIfe of Tube of the 76-MM Gun Cannon, M32 (T91E3) For: Tank, Combat, FT, M41A3 Estimated Round Life and EFC Factors Based on Use With Specific Ammunition

Round						
Type	M-model	T-model	Charge	Zone	Round life	EFC
AP-T	M-339				350	1.00
TP-T	M340				350	1.00
TP-T	M340A1				350	1.00

Table 4-5.1. Estimated Remaining LIfe of Tube of the 76-MM Gun Cannon, M32 (T91E3) For: Tank, Combat, FT, M41A3 Estimated Round Life and EFC Factors Based on Use With Specific Ammunition--Continued

Round						
Type	M-model	T-model	Charge	Zone	Round life	EFC
HVAP-T	M319	T66E3			318	1.10
HVTP-T	M320	T74E1			318	1.10
HVAP-DS-T	M331A2				250	1.38
HEAT-T	M496	T810E26			200	1.75
CSTR	M363	T3E7			450	0.78
HE	M352				1600	0.22
SMK	M361				1500	0.24
SMK	M361A1				1500	0.24

Only 7 retubings are allowed.

The bore is chrome-plated.

Table 4-6. Life of the 105-MM Howitzer Cannon, M2A1 Tube Based on EFC Round Count

Major item	Tube model	EFC round life of tube	EFC factors	Breech life
Howitzer, M101, M101A1	M2A1	5,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and two tubes
Howitzer M102	M137	5,000 rounds	Zone 7 = 1.00 Zone 1-6 = 0.25	Original and three tubes

NOTE

After 1,500 EFC rounds, notify DS each 200 rounds (regardless of EFC) to inspect muzzle keyways. After 2,000 EFC rounds do this each 100 rounds (regardless of EFC).

APPENDIX

REFERENCES

1. Forms

DA Form 2408-4 ..... Weapons Record Data

2. Technical Manuals

TM 9-4933-200-35 ..... DS, GS and Depot Maintenance Manual: Pull-over Gages and Borescope M1 and M2

3. Other Publications

AR 385-40 ..... Accident Reporting and Records

DA PAM 738-750 ..... The Army Maintenance Management System (TAMMS)

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The Adjutant General

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To be distributed in accordance with DA Form 12-37, Operator maintenance requirements for all Guns, Howitzers, Self-Propelled, Tanks, Combat, Full-Tracked, 76mm, M41, M41A2, M41A3, including Trainer M17, M17A1, M48A1, M48A2C including Flame Thrower, M67A1, 105mm, M60, M6A1, Armored Reconnaissance Assault, M551, M55A1, Combat Engineer, Full Track M728 and DA Form 12-40, Section I, Operator maintenance requirements for all Weapons.

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PAGE NO	PARAGRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
3		2		Item 10. Change illustration. Reason: Tube end shown assembled on wrong side of lever cam
109		51		Item 3. The NSN and P/N are not listed on the AMDF nor the MCRL. Request correct NSN and P/N be furnished
2-8			2-1	Preventive Maintenance Checks and Services Item 7 under "Items to be inspected" should be changed to read as follows: Firing linkage and firing mechanism pawl.
12	1-6a			Since there are both 20- and 30-round magazines for this rifle, data on both should be listed

SAMPLE

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER: JON SMITH, S/SGT AUTOVON 582/XXXX

SIGN HERE: Jon Smith

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